DECEMBER 1955

MACHINE DESIGN

A PENTON PUBLICATION

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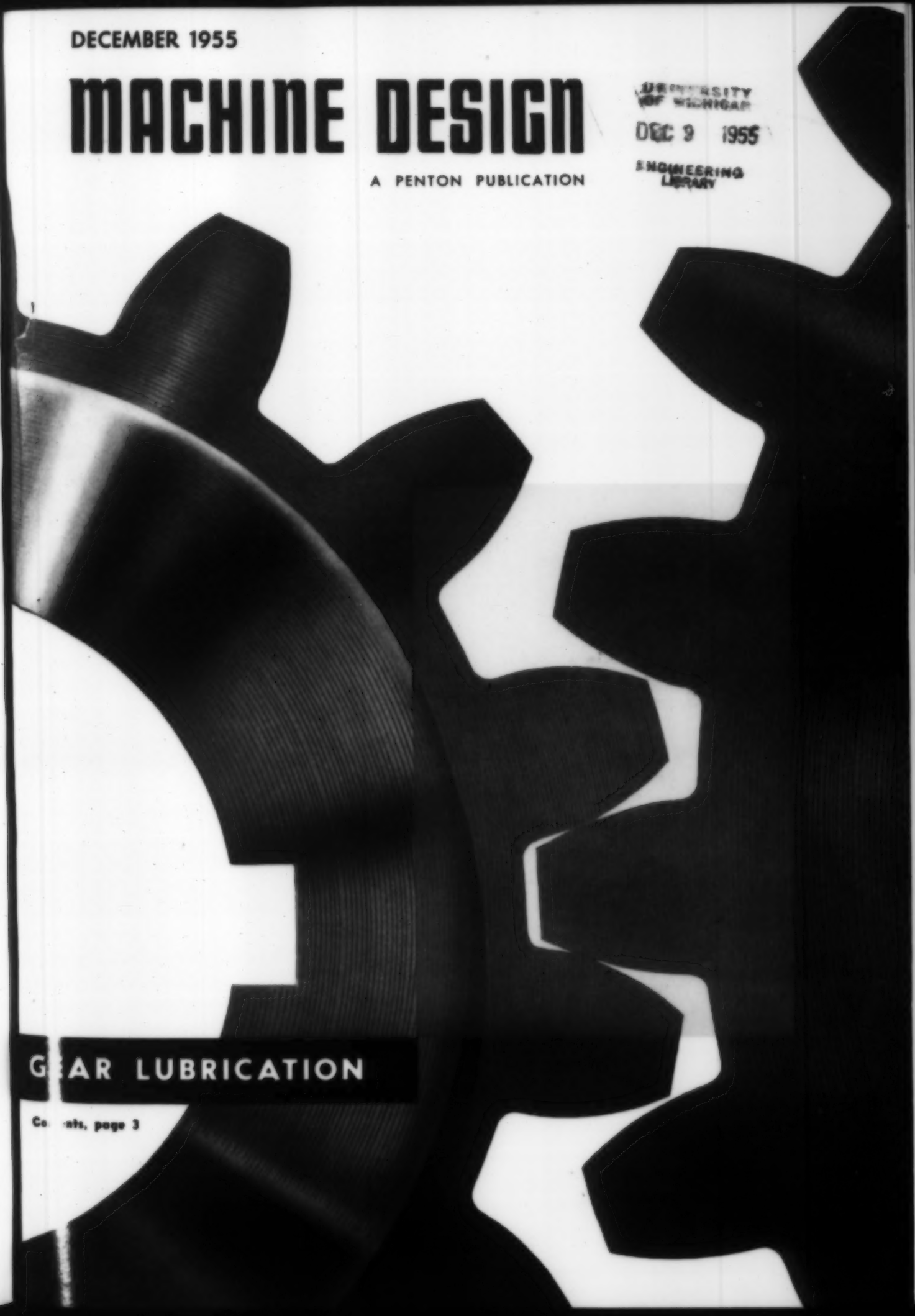

GEAR LUBRICATION

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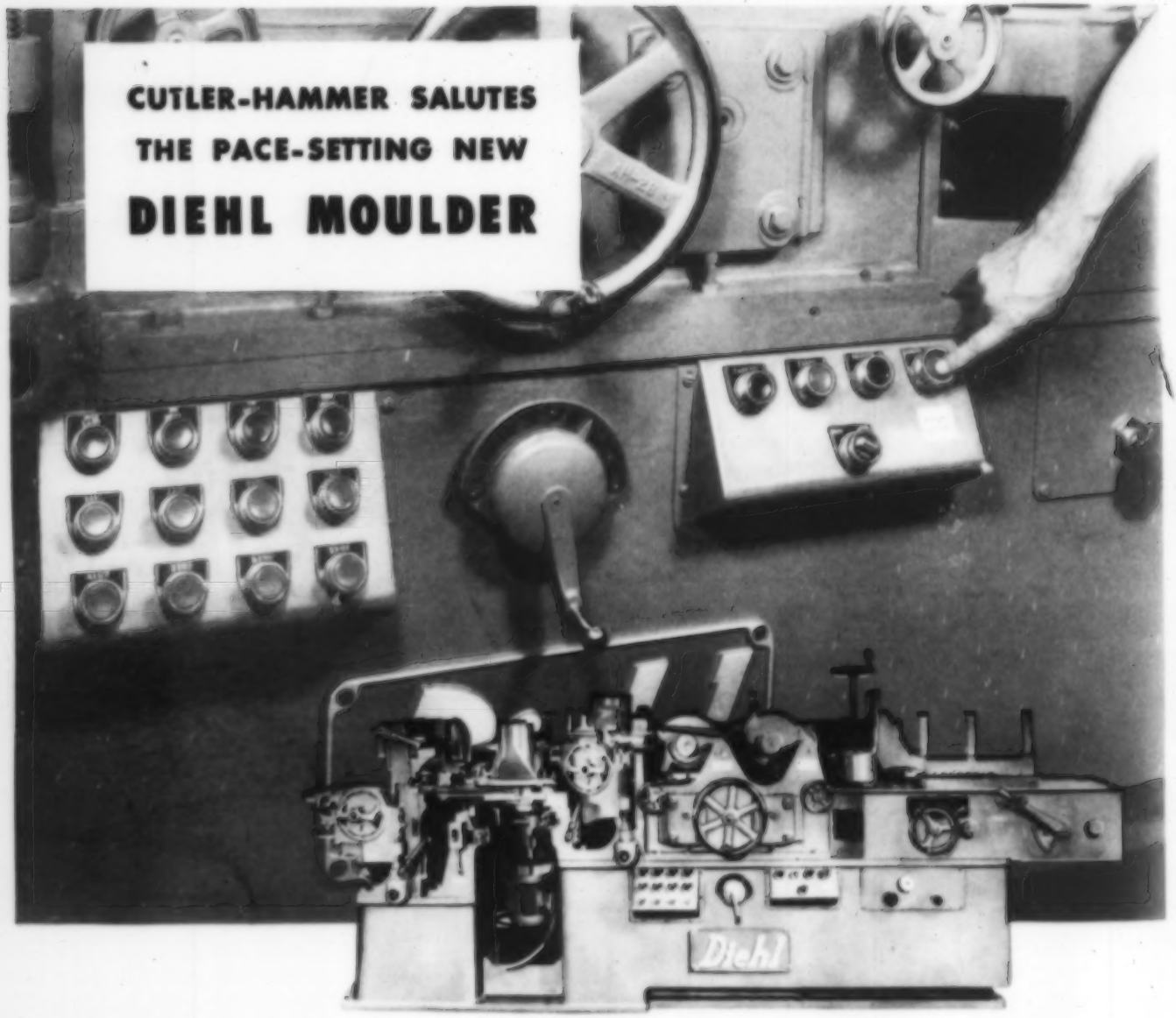

The New Diehl 12" Moulder

Cutler-Hammer Three-Star Motor Control is featured. More than twenty such components are standard equipment on the compact control panel of each machine. All pushbuttons for control of the machine's functions are the new Cutler-Hammer Heavy Duty Oil-Tight Pushbuttons.

The G. M. Diehl Machine Works, Inc., Wabash, Indiana has long been recognized as a leading manufacturer of dependable woodworking machinery. Dependability is important in woodworking machinery. The service is rugged. The conditions under which woodworking machines operate impose many problems not found in other industries.

Cutler-Hammer is proud to salute this fine company for its well-earned reputation . . . and for its latest achievement in advanced engineering, the new Diehl 12" Moulder.

Typical of the leadership shown in the design of the new Diehl 12" Moulder is the motor control used. Cutler-Hammer Three-Star Motor Control is featured. More than twenty such components are standard equipment on the compact control panel of each machine. All pushbuttons for control of the machine's functions are the new Cutler-Hammer Heavy Duty Oil-Tight Pushbuttons. By all comparisons, this is the finest electrical equipment available . . . the natural choice wherever precise performance and dependability are basic design objectives. CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

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CUTLER-HAMMER
MOTOR CONTROL
C-H
THE MARK OF BETTER MACHINES

THE PROFESSIONAL JOURNAL
FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

DECEMBER 1955
Volume 27—No. 12

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Over the Board

What Your Boss Reads

Did you ever wonder whether your boss looks at things the same way you do? If you have, you may be interested in a study we made recently. We do a lot of reader surveying—asking readers what, why and how they read MACHINE DESIGN. Recently, we did a survey on top-level engineers—chief engineers, vice presidents in charge of engineering and similar men. Here are the results for the five "best" editorial departments (not including articles), in order:

Engineering News Roundup
Scanning the Field for Ideas
Editorial
New Parts and Materials
Design Abstracts

Now, we also survey our "regular" readers at frequent intervals. For all of last year, here are the top five:

Scanning the Field for Ideas
New Parts and Materials
Editorial
Engineering News Roundup
Design Abstracts

Quite similar, aren't they?

Standardized Speech

A plea was made by Richard S. Burke of Sears Roebuck at a recent Standards Engineers Society meeting for proper definition of words—essentially standardization of comunication. We particularly enjoyed a newspaper report on his talk. Here is the pertinent quote, from the Hartford (Conn.) *Courant* of Sept. 30:

"The executive stressed, however, the importance of standardization in communication. It is important, he said, that when a product is advertised as 'wahable,' for example, the consumer knows just what is meant."

Even if we engineers don't.

Ben Franklin Says . . .

Next year, we understand is the 250th anniversary of Benjamin Franklin's birth. Many organizations, in co-operation with the Franklin Institute, are planning all kinds of speechmaking, celebrations and various other interesting events. We'd also like to add our own little contribution. It's a quote from wise, old Ben that we editors think belongs on the wall of everyone with aspirations to become an author: "If you would not be forgotten, either write things worth reading or do things worth writing."

This Months Cover

As gearing capacity goes up, and size per unit horsepower goes down, gear lubrication problems grow. Dr. Spyro Kyropoulos, a research chemist with a very practical design approach, gives some of the answers to the problems of lubricating standard and high-capacity gearing on Page 190. George Farnsworth's cover highlights this important design area.

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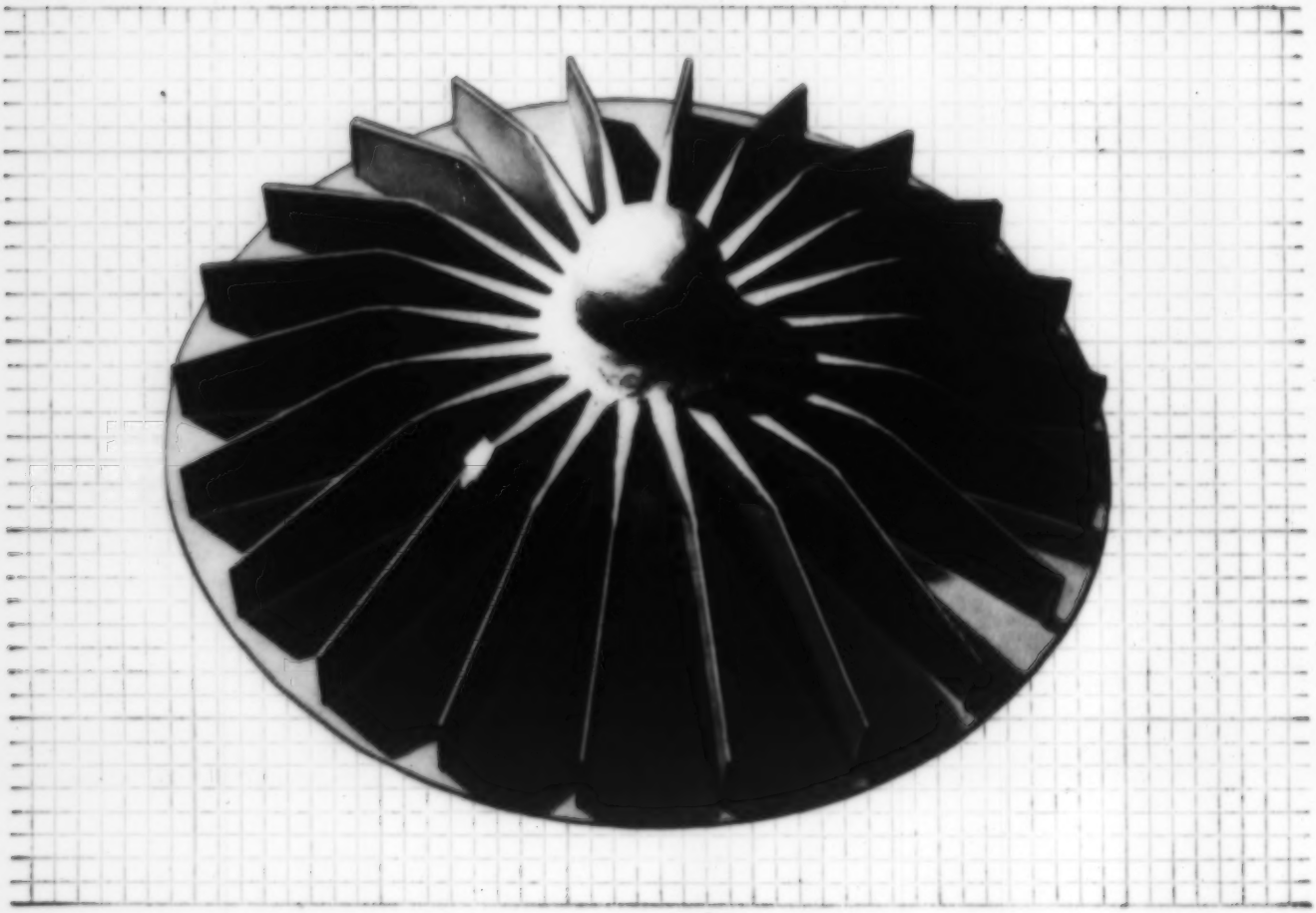

22-inch Diameter Wheels Investment Cast . . . at a 50% Saving

Turbine wheels, 22 inches in diameter and weighing close to 100 pounds, are now being mass-produced by HAYNES' precision-investment-casting process. The wheels are made of stainless steel and are used in the turbocharger section of a compressor. At one time a lengthy profile machining operation was needed to shape the intricate blades. Investment-casting eliminated this operation and cut production costs in half.

The savings realized on this wheel are typical of the many economies made possible by HAYNES' precision-investment-casting process. This modern mass-production method eliminates many machining, grinding, and assembling operations. Intricate contours, odd-shaped cavities, and thin edges can all be cast to size. Two or more parts can be designed and produced as one integral part. In most instances, an investment-cast part can be placed in operation as soon as it is delivered.

For information on how you can use HAYNES' investment-casting process to keep production costs down, write to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

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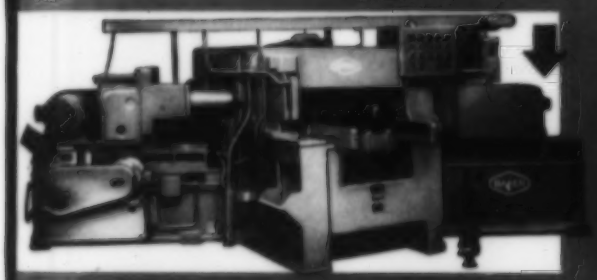
OILGEAR "JK" FLUID POWER FEED PUMPS

AS APPLIED TO

BAKER BROTHERS MACHINES

Two Oilgear "JK" Feed Pumps on Baker's Multiple Station Automatic Transfer Type Machine.



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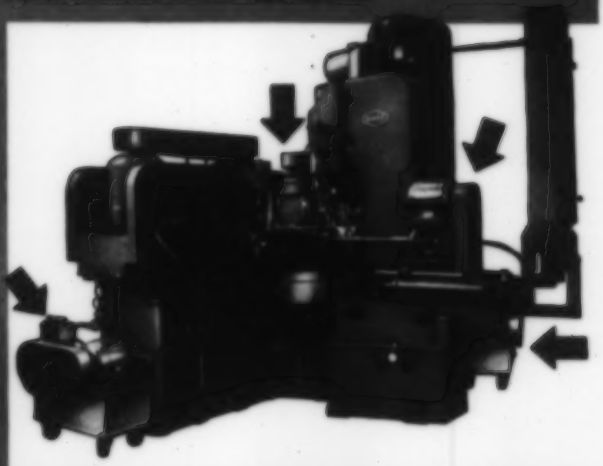
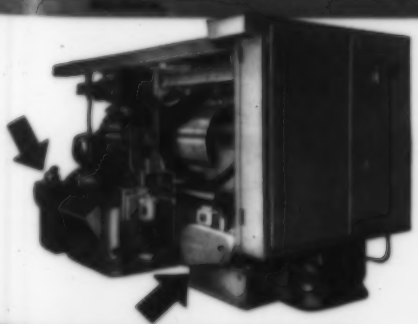
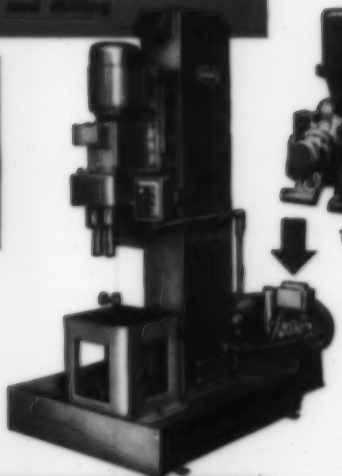
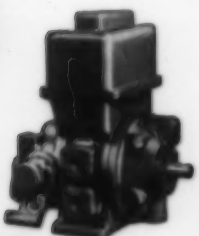


Four Oilgear "JK" Feed Pumps on Baker's Multiple Head Drilling, Boring, Reaming and Milling Machine.





Oilgear "JK" Feed Pump on Baker's Double Spindle Vertical Drilling, Boring and Reaming Machine.



Type "JK" Pump Built in four sizes.

HOW CAN YOU USE THESE SIMPLE, VERSATILE, EASILY APPLIED, PROFITABLE UNITS?

Baker Brothers, Inc., pioneers in machine building, users of Oilgear Feed Pumps since 1925, employ Oilgear "JK" Fluid Power Variable Delivery Feed Pumps on a host of machines including the headline-making 100-foot-long transfer machine and their own commercially available portable hydraulic power unit which you can see in photos Nos. 1 and 3 on this page.

The Oilgear "JK" Feed Pump offers many advantages, not the least of which are easy applicability and accessibility. There's no need in many cases for machine redesign and engineering. And this unit does so much to speed cycle time—traverse speed for example can be 265 times feed rate—that production rises dramatically and costs subside. Both coarse and fine feed rates can be varied infinitely so you at once discover the best rates for your work—and the automatic built-in compensator holds the selected fine feed *unvaryingly*. All functions are controlled automatically, semi-automatically or manually.

Evidence of Oilgear "JK" dependability is growing. In one large automotive plant, now 75% changed over to Oilgear, hydraulic maintenance staff was cut from 6 men to one man per shift. In another great automotive plant, the records show Oilgear is found to give the finest service of all.

There's much more to tell especially about two new units added to the "JK" line. Why don't you send for free literature that gives all the facts and figures. So you won't forget, send for it now.

THE OILGEAR COMPANY
1568 W. PIERCE STREET
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OILGEAR
Fluid Power

PIONEERS . . . NOW THREE PLANTS FOR FLUID POWER

PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

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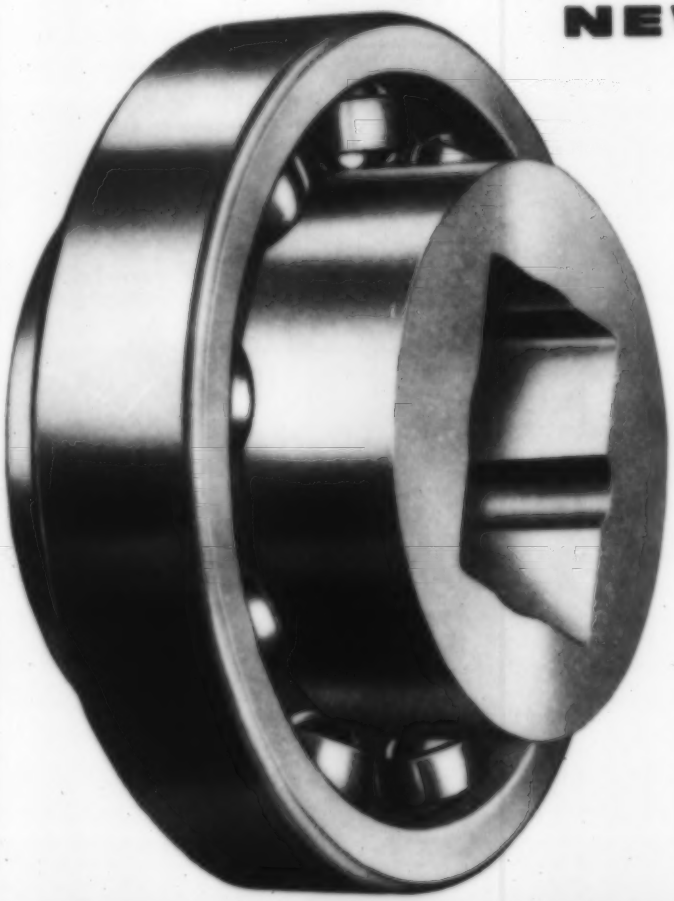
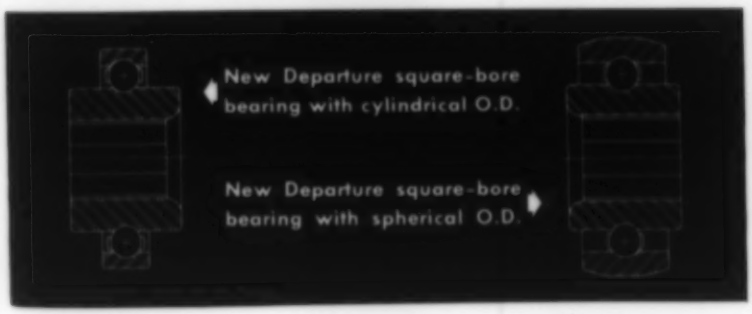
BALL BEARINGS





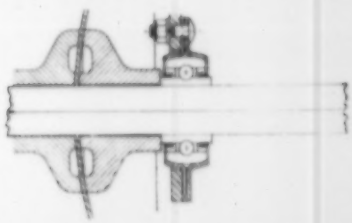
Square-bore bearing cuts costs for disc harrow manufacturers!

New Departure's new square-bore ball bearing mounts directly on square axles, cutting costly machining operations on adapter spools and eliminating inner ring slippage. The design permits use of a smaller bearing, and fewer, less expensive mounting components are needed.

Precision ground areas on the bearing provide ideal contacting surfaces for installation of triple-lipped seals, assuring full protection under the most stubborn dirt conditions. Lubricated for long, hard service, maintenance requirements are reduced to virtually zero. Write for full details.

TYPICAL APPLICATION OF NEW DEPARTURE'S SQUARE-BORE BALL BEARING

Shown at the right is a New Departure square-bore ball bearing, with spherical O. D., mounted on the square shaft of a disc harrow. This is a typical example of how New Departure meets the special needs of industry by designing, developing and manufacturing the right bearing to fit the specific job. Call on New Departure for help in solving your bearing problem.



NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

Engineering News Roundup

Starting Salaries Up For NYU 1955 Graduates

Aeronautical and Industrial Engineers Highest Paid

NEW YORK—Graduates of the New York University College of Engineering in 1955 received an average of five definite job offers each, according to a report issued by Dean Thorndike Saville.

The average starting salary for the June graduating class was $401 a month, an increase of 11.5 per cent over the figure for the Class of 1954. Aeronautical and industrial engineers were the highest paid. The average for each of these two groups was $430 a month.

Average beginning salaries in private industry were higher than those offered by government agencies employing engineers — $405 per month against $338.

"The survey indicates clearly that competition for engineering graduates is growing," said Dean Saville. "Salaries advanced again and companies continued recruiting on the campus months before the end of the school year. Because of its relatively lower salaries, civil service—local, state, and federal—continued to be at a disadvantage in attracting engineering employees."

Starting salaries have increased in each of the last eight years, with the exception of 1949. The 1955 average is 76 per cent higher than that of 1947 ($227).

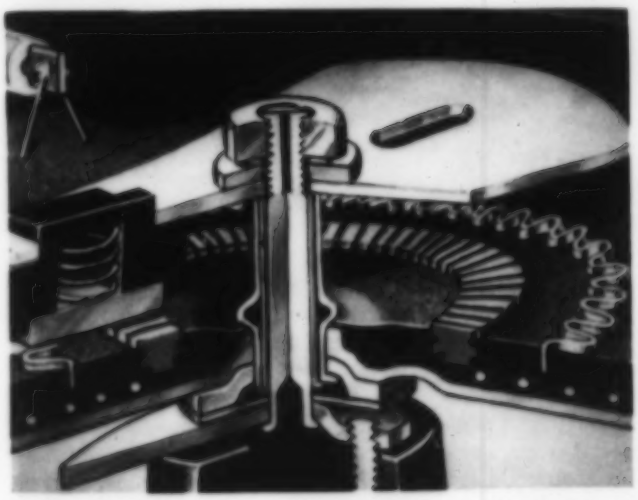
This year's survey was based on personal interviews with 122 of the 185 seniors who registered last spring with the NYU Office of placement Services.

WORLD'S LARGEST die handler can easily pick up this fork truck. Made by Automatic Transportation Co., the device is designed to handle dies weighing up to 55 tons. Two winches are supplied to help lift the dies into and out of presses. Total capacity for any type of load is 110,000 lb

Extruded Shape Cuts Assembly Over Half

A Ward Leonard Type M Vitrohm rheostat using contacts made from extruded shapes

Ingenious application eliminates hand assembly, makes absolutely uniform stationary contacts in Ward Leonard power rheostats



CROSS SECTION VIEW of a Ward Leonard Vitrohm Type S rheostat showing how contacts are embedded in a vitreous enamel.

Ward Leonard Electric Co., Mount Vernon, N. Y., makes a line of high quality power rheostats marketed under the trade-name Vitrohm. Anywhere from 41 to 161 individual stationary contacts, or buttons, have to be embedded with their resistance elements in an insulating vitreous enamel—all contacts uniformly set and spaced, for uniform performance. Their patented process originally used buttons blanked out of sheet brass—hand assembled and spaced on a steel wire to hold them while the vitreous enamel was fired.

Ward Leonard refined the process and for four models now starts with the extruded shapes shown above. The stock is accurately slotted for correct spacing, forming a continuous line of buttons connected by a triangular "wire"—which is an integral part of the extruded shape. When sections are curved, the buttons remain uniformly spaced and oriented. After the button assemblies are embedded in the vitreous enamel, the connecting wire is easily milled off. Ward Leonard gets absolute uniformity with less effort and fewer rejects—it gets healthy dollar savings, despite the fact that more than half of the extruded shape is milled out.

Imagination applied to extruded shapes can pay big dividends—lower direct labor costs—fewer machining operations—less scrap—improved product quality. Your Anaconda representative will be glad to work with you. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5284

ANACONDA®

EXTRUDED SHAPES

Short cuts to a finished product

Rounding Up the 1956 Automobiles—2

SIX cars reported on this month have been restyled for 1956 to emphasize characteristics by which their makers seem to want the respective lines identified. Dodge's "Forward Look" is made bolder, and DeSoto presents a forward thrust appearance available in a record number of color combinations. Makers of large cars stress quality and comfort.

The Cadillac line has two new models in a total of ten. All the models have a front grille made of aluminum available in the colors of natural aluminum or gold. Certain other parts of exterior trim are also aluminum. Saber-spoke wheels made of aluminum are standard on the Eldorado; optional on other models.

The 1956 Clipper is the Studebaker-Packard entry in the medium-price field. Like Packard, the Clipper has torsion-bar wheel suspension. Pushbutton gear shift is optional on Clippers and standard on Packards.

Mercury offers 13 models with a choice of three engines depending on the type of transmission selected.

MERCURY

Mercury in 1956 offers a total of 13 models in its Montclair, Monterey and Custom series. The cars are finished in 15 solid colors and 60 two-tone combinations. More powerful engines, equipped with

12-volt electrical systems, and several new safety devices are mechanical features of the new cars.

The most powerful of the three Mercury engines is available only with Merc-O-Matic transmission and uses premium fuel. For the use of regular fuel and

Engine Specifications

	Std. & Over-Drive Trns.	Merc-O-Matic Transmission	
Type	OHV, Vee	OHV, Vee	OHV, Vee
No. cyls.	8	8	8
Bore & stroke (in.)	3.80 x 3.44	3.80 x 3.44	3.80 x 3.44
Displ. (in.³)	312	312	312
Comp. ratio	8.0 to 1	8.4 to 1	9.0 to 1
Bhp. max	210 @ 4600	215 @ 4600	225 @ 4600
Torque, max (lb-ft)	312 @ 2600	317 @ 2600	324 @ 2600

Size and Weight

Wheelbase (in.)	119
Length (in.)	206.4
Width (in.)	76.4
Height (in.)	60.6*
Weight (lb)	...

*Monterey and Custom Sedans.

Merc-O-Matic transmission, Mercury provides a 215-hp engine. A 210-hp engine is intended for Mercury's standard and overdrive transmissions. On all models, 12-volt electrical systems are standard, and dual exhausts are standard on Montclair, Monterey and station wagon models.

Standard safety features of the new Mercurys include an impact absorbing steering wheel, double-grip door locks and rear-view mirror vinyl-backed to prevent shattering. Optional safety features include padding for the instrument panel and seat belts for the driver and one to five passengers.

CLIPPER

As a major part of the Studebaker-Packard program to develop automobiles for all price classes, the 1956 Clipper line is designed for the medium-price field. The Clippers are promoted as powerful

cars styled in good taste. Super and DeLuxe Clippers have two-barrel carburetors and rated horsepower of 240. Custom Clippers with four-barrel carburetors deliver 275 horsepower. Torsion-bar suspension system with "load-levelizer" is standard equipment. An electrically-activated pushbutton automatic transmission is optional. Clipper safety features include interlocking safety door latches, power steering, tinted glass windows and foam-rubber instrument-board padding. 1956 Clippers are available

Ostuco Welded Tubing

. . . Specified by men with responsibility

OSTUCO *Welded Tubing* offers design engineers unlimited latitude to create a variety of original but practical product designs.

***Sales Managers can meet . . . and beat* the competition with products incorporating OSTUCO Welded Tubing.**

***Cost Control is easier* with OSTUCO Welded Tubing. Low initial cost and less time-consuming processing mean *important* savings.**

***Extra strength*, less weight, and uniformity of OSTUCO tube walls insures top quality finished products time after time. No rejects here.**

***Production runs smoother . . . faster* with OSTUCO Welded Tubing components. Assembly time is reduced, expensive operations eliminated. Production schedules are on *time*.**

***OSTUCO's single-source* service design (manufacturing and fabricating under one roof) means error-free handling of *every* order—large or small. Purchasing can relax . . . less follow-up necessary with OSTUCO.**

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING
—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America

SALES OFFICES: BIRMINGHAM • CHARLOTTE • CHICAGO (Oak Park) CLEVELAND • DAYTON • DENVER • DETROIT (Ferndale) HOUSTON • LOS ANGELES (Beverly Hills) • MOLINE NEW YORK • NORTH KANSAS CITY • PHILADELPHIA PITTSBURGH • RICHMOND • ROCHESTER • ST. LOUIS ST. PAUL • SALT LAKE CITY • SEATTLE • TULSA • WICHITA

CANADA, RAILWAY & POWER ENGR. CORP., LTD.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
117 Liberty Street, New York 6, New York

Engine Specifications

Type	OHV, Vee
No. cyls.	8
Bore & stroke (in.)	4 x 3⅛
Disp. (in.³)	352
Comp. ratio	9.5 to 1
Bhp, max	275 @ 4600*
Torque, max (lb-ft)	380 @ 2800†

*240 @ 4600 for Super and Deluxe models.
†350 @ 2800 for Super and Deluxe models.

Size and Weight

Wheelbase (in.)	122
Length (in.)	214⅛
Width (in.)	78
Height (in.)	62
Weight (lb)	...

in more than 40 solid colors and two-tone combinations. Interiors can be finished in 38 combinations of fabric and leather materials.

PACKARD

Packards for 1956 feature electric "pushbutton" gear shift, more powerful engines with increased torque, nonslip differentials and a 20 per cent increase in fuel economy. In addition to a wide se-

lection of regular colors, Packards can be custom-finished. Packard interiors feature reversible seat and back cushions. The Packard torsion-bar suspension system introduced last year has been improved for 1956. An element of the system is the automatic "load-levelizer" which compensates for variations in car load and holds the body level despite road conditions. This feature permits headlights to be lowered one inch in 1956 models. The new Packards have an electric transmission control with six buttons which correspond to six driving ranges available with Ultramatic. Each pushbutton electrically activates its own driving selection and locks out all others. Packard engines are claimed to have the highest compression ratio and to deliver the highest torque of 1956 cars. Safety features include safety door latches, power steering, instrument panel covering and armrest-type seat belts.

Engine Specifications

Type	OHV, Vee
No. cyls.	8
Bore & stroke (in.)	4⅛ x 3⅛
Displ. (in.³)	374
Comp. ratio	10 to 1
Bhp, max	310 @ 4600*
Torque, max (lb-ft)	405 @ 2800

*290 @ 4600 for Patrician and Packard 400 models.

Size and Weight

Wheelbase (in.)	127
Length (in.)	218.5
Width (in.)	78
Height (in.)	61.7*
Weight (lb)	...

*62.3 for Patrician models.

DODGE

Extensive restyling and numerous mechanical improvements are featured in the Dodge lines for 1956.

The Dodge Forward Look is made bolder by new body designs, and a pushbutton drive selector is emphasized along with more powerful engines and safety devices.

Engine Specifications

	Get-Away 6	Red Ram	Super Red Ram
Type	In-line	OHV, Vee	OHV, Vee
No. cyls.	6	8	8
Bore & stroke (in.)	3.25 x 4.63	3.63 x 3.256	3.63 x 3.80
Displ. (in.³)	230	270	315
Comp. ratio	7.6 to 1	7.6 to 1	8 to 1
Bhp, max	131 @ 3800	189 @ 4400	218 @ 4400*
Torque, max (lb-ft)	203 @ 2000	266 @ 2400	309 @ 2000†

*Optional 230 @ 4400.
†Optional 316 @ 2400.

Size and Weight

Wheelbase (in.)	120
Length (in.)	212.0
Width (in.)	74.6
Height (in.)	60.6
Weight (lb) (unofficial)	3568

Four model series which comprise the 1956 line are named Coronet, Royal V-8, Custom Royal V-8 and Station Wagons which in turn consist of two-door Suburban models and four-door Sierra models. Dodge offers several cars in these lines with a choice of power, either the "Get-Away Six" or the eight-cylinder Red Ram and Super Red Ram motors.

All Dodge motors have increased horsepower and 12-volt electrical systems. The Super Red Ram V-8 can develop 230 hp by the addition of accessories.

the winner

From the collection of Lewis Winant, New Jersey Arms Collectors Club. Maker: Le Conte, Paris, France, 1758-1763. An 11-by-14 inch print of this illustration with part and lettering omitted is available free on request on company letterhead.

In producing this cam of sintered iron powder, Bound Brook competed directly with other forms of metal fabrication — and emerged victorious. Bound Brook's knowledge and experience with powder metallurgy combined the plus values of uniform density, consistent dimensional accuracy, good surface finish and high speed production to create a superior part at moderate cost. Whenever you are challenged with a metal-fabrication problem which is not easily solved by conventional metal-working methods why not call in your Bound Brook Man? There's no obligation for inquiring—and, in conjunction with your engineers, he could produce a winner!

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO. EST. 1883 BOUND BROOK, N. J.

Pioneer in

POWDER METALLURGY BEARINGS + PARTS

New safety features in Dodges for 1956 are safety door latches, vacuum-operated power brakes, and improved lights both fore and aft.

DE SOTO

For 1956, DeSoto offers its two regular lines, Firedome and Fireflite, restyled to emphasize forward thrust appearance. Both lines are available in a choice of 85 color combinations—a record number for DeSoto. Complementing the appearance features,

DeSoto offers several standard and optional mechanical improvements. Horsepower of the engines in both lines has been increased with longer piston stroke and higher compression ratio. A drive selector that replaces former gear-shift mechanisms is standard on Fireflite models. The 1956 DeSotos also

Engine Specifications

	Firedome	Fireflite
Type	OHV, Vee	OHV, Vee
No. cyls.	8	8
Bore & stroke (in.)	3.72 x 3.80	3.72 x 3.80
Displ. (in.³)	330.4	330.4
Comp. ratio	8.5 to 1	8.5 to 1
Bhp, max	230 @ 4400	255 @ 4400
Torque, max (lb-ft)	305 @ 2800	350 @ 3200

Size and Weight

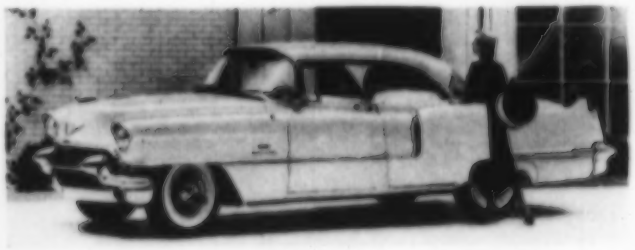
	Firedome	Fireflite
Wheelbase (in.)	126	126
Length (in.)	217.9	217.9
Width (in.)	78.3	78.3
Height (in.)	60.6	60.6
Weight (lb)	4120	4120

have a new braking system in which power components are optional, new windshield wipers, a 12-volt electrical system, more powerful lights and safety door locks. Accessories include an instantaneous heater, record player, steering wheel watch, three-element horn and dual radio antennae. The gas tank has been enlarged to hold 21 gallons.

CADILLAC

Cadillac in 1956 offers ten body styles in three series. Presented for the first time are the Sedan de Ville, a four-door hardtop, and the Eldorado Seville, a limited production model to supplement Cadillac's present Eldorado Biarritz.

All Cadillac models have been restyled. Front end appearance is marked by a new aluminum grille of narrow-spaced cellular design finished in either gold or silver color.



Two new engines power the 1956 Cadillacs, one of 285 hp and another of 305 hp installed only on the Eldorado models. The more powerful engine has dual four-barrel carburetors. New elements of the engines are the block and cylinder head, distributor, hydraulic valve lifters, starting motor, fan, voltage regulator, fuel pump, carburetor, intake manifold and main bearing journals. The new engines are used with a new transmission, called the "controlled coupling" Hydra-Matic, standard on all 1956 Cadillacs. The new transmission is said to be more durable than its predecessors and to operate more quietly. Other mechanical improvements for 1956 include a new power brake system and a lower ratio steering mechanism with a higher output steering pump. Mechanical elements refined for 1956 include the shock absorbers, vacuum-type windshield wipers and radio antenna raised and lowered electrically.

Engine Specifications

Type	OHV, Vee
No. cyls.	8
Bore & stroke (in.)	4.0 x 3.625
Displ. (in.³)	365
Comp. ratio	9.75 to 1
Bhp, max	285 @ 4600; 305 @ 4700*
Torque, max (lb-ft)	400 @ 2800; 400 @ 3200*

*For engines in Eldorado models.

Size and Weight

	Series 62	Series 60	Series 75
Wheelbase (in.)	129	133	149½
Length (in.)	214.9*	225.9	235.7
Width (in.)	80	80	80
Height (in.)	62*	62	63.9
Weight (lb) (unofficial)	4550	4610	5050

*Figures given are for sedan.

(To be concluded in January)

Potter and Brumfield, electric relay manufacturers, announce the completion of a new engineering and research building. The new building contains 10,000 sq ft.

Machine Writes Foreign Languages

Multilanguage Printer Developed by Army

NEWARK, N. J.—More than 50 languages may be typed on a newly developed typewriter-like machine, according to a recent announcement by the Department of the Army. In fact, the typist need not be acquainted with the language he is typing.

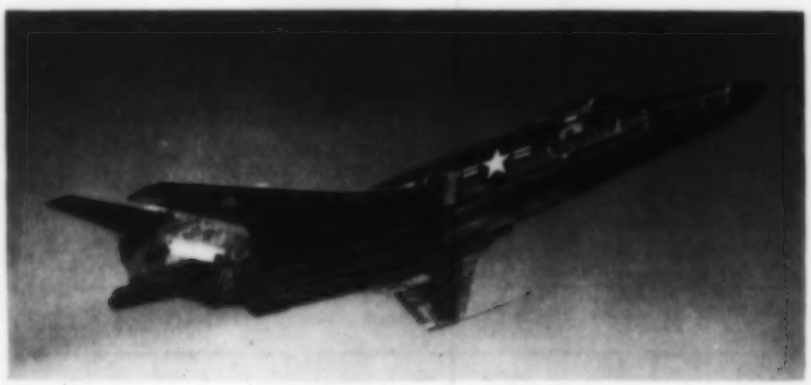
A modified Coxhead Vari-typer, equipped with interchangeable fonts, has been designed to write Hebrew, Arabic, Sanskrit, Burmese and similar languages using characters other than the Latin alphabet. A reverse carriage model accommodates languages reading from right to left.

An interpreter is still a necessary part of the operation. His job is to write the message in the language desired. He then substitutes appropriate numbers for the characters, using symbols to indicate punctuation. For example, a circle indicates a capital letter. A diagonal signifies a word end.

After inserting the proper font in the machine, the operator strikes the keys according to the numerical sequence of the message. When complete, the typing resembles commercial printing.

One of the uses of the machine will be to permit an operator not familiar with little known foreign tongues to compose printed matter. Better communication with some of these areas of the world is expected to be one result of this development. Another application will be in mobile psychological-warfare printing units.

This foreign language machine enables an operator to type up to 50 different languages without any knowledge of the language itself



SUPERSONIC AERIAL PHOTOGRAPHY is the mission of the RF-101A Voodoo, above, recently delivered to the U. S. Air Force by McDonnell Aircraft Corp. The plane carries a combination viewfinder which gives the pilot a clear view of the terrain below and ahead of the airplane. An air conditioning system is necessary to obtain maximum lens efficiency. Several types of cameras are quickly interchangeable and night photos can be taken with the aid of flash cartridges

NYU Hall of Fame Elects Wilbur Wright, Westinghouse

Poor Showing for Davy Crockett and Buddies

NEW YORK — Recent elections at New York University have added the names of Wilbur Wright, Thomas Jonathan (Stonewall) Jackson, and George Westinghouse to the university's illustrious Hall of Fame. Elections to this national shrine are held every five years. Nominees must be outstanding American citizens dead at least 25 years. The 1955 elections have duly recognized technical accomplishment, but America's future engineers now in the juvenile set will be dismayed to learn that nominees "Kit" Carson, "Buffalo Bill" Cody and Davy Crockett received no votes at all.

(*Continued on Page* 24)

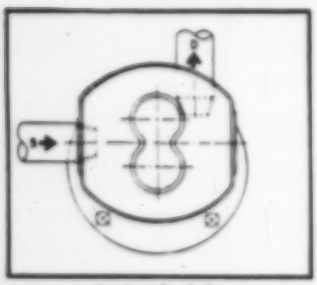
New MONOBLOC lets you hook up

WORTHINGTON MONOBLOC PUMP

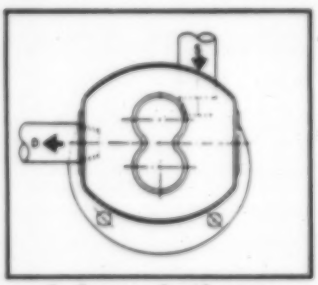
type GAFT, features rotary pump and close-coupled motor. It's just like the famous Worthington Monobloc centrifugal pump line except that coupling allows easy pump removal.

How you can use dual intake and discharge openings

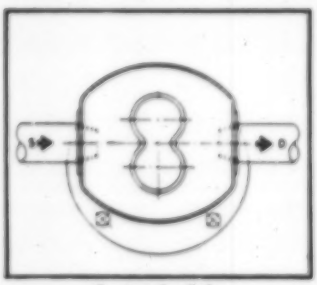
HERE ARE EIGHT OF THE 28 POSSIBLE ARRANGEMENTS:



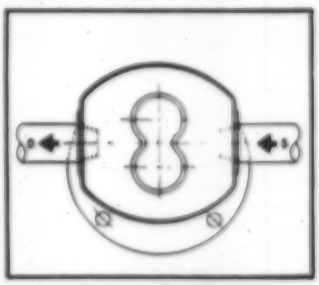
1. Intake left. Discharge top right.



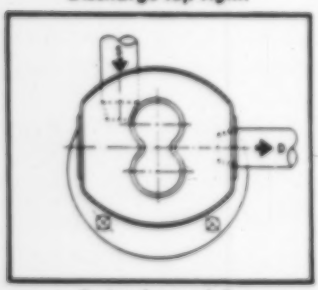
2. Same as 1 with pump direction reversed.



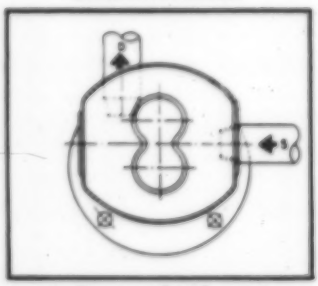
3. Intake left. Discharge right.



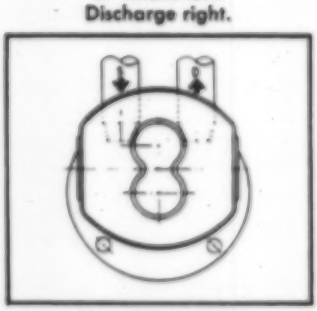
4. Same as 3 with pump direction reversed.



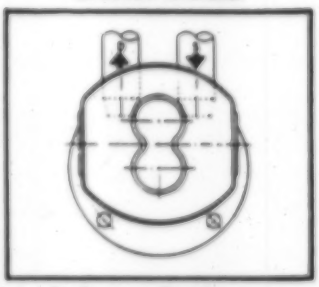
5. Intake top left. Discharge right.



6. Same as 5 with pump direction reversed.



7. Intake top left. Discharge top right.



8. Same as 7 with pump direction reversed.

rotary pump piping 28 ways!

This new Worthington Monobloc rotary pump is easy to design into compact new equipment or to adapt to existing layouts.

Dual suction and discharge openings, reversible pump direction, and four pump flange positions on motor add up to 28 possible arrangements to simplify pipe layout.

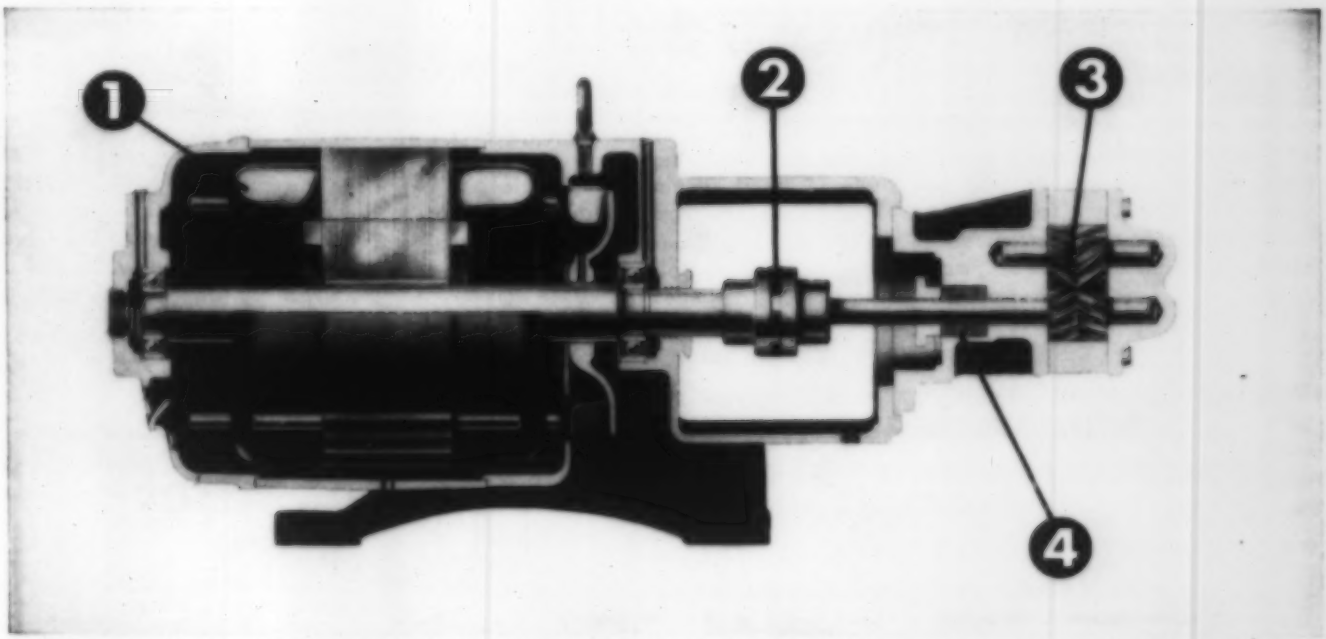
The Monobloc motor, on the new rotary, effects the same savings it has marked up for years on Worthington Monobloc centrifugal pumps. Fewer parts mean a more compact overall assembly that's easier to manufacture so it costs you less than separate pump, motor, coupling, and baseplate.

Standardization of pump and motor flange diameters and shaft lengths permit any pump to be mounted on any Monobloc motor.

There are no alignment problems with the Monobloc. Pump and motor are automatically aligned — eliminating end-thrust, binding, pipe strains, and resulting pump wear.

It's easy to service, too. A shaft coupling on the Monobloc rotary allows pump removal without disturbing the motor.

Get the whole story on the new Monobloc rotary pumps, type GAFT. Write today for bulletin W-484-S1. It gives complete data on features and applications. Worthington Corporation, Section PC.5.21, Harrison, New Jersey. PC.5.21



CUTAWAY VIEW OF GAFT PUMP. Available in four sizes, from 2 to 27 gpm at heads up to *150 psi*. Note Monobloc motor (1) available at 1800, 1200, 900 rpm, for all commonly used voltages, phases, and frequencies; motor-pump coupling (2) that allows quick pump removal; all-iron herringbone gear pump (3); packed stuffing box (4); a mechanical seal and/or relief valve are optional standard features.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON *YOUR* EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Allspeed Drives

(Continued from Page 21)

First Design Engineering Show Announced

Exposition to be Launched At Philadelphia, May 14-17

NEW YORK—The first exposition and conference devoted exclusively to the needs of design engineers will be held on May 14 to 17, 1956. Called the "Design Engineering Show," the exposition will be held at Convention Hall in Philadelphia.

Conference program, consisting of papers and open forum discussions, will be arranged jointly by four technical publications — MACHINE DESIGN, *Product Engineering*, *Electrical Manufacturing* and *Materials & Methods*. Exhibits will feature mechanical, electrical, hydraulic and pneumatic components and controls; materials and finishes; and many other parts and components used in designed products.

In the past, no single show or exhibit has been specifically aimed at the interests and technical needs of design engineers. The new show, to be held yearly, will provide a meeting place for designers to keep posted on new developments and find answers to specification, selection and design problems on parts and materials.

Need for such a show is emphasized by the tremendous expected growth in engineering activity. Gross U. S. national product is expected to increase almost 40 per cent in the next decade, underlining the growing need for such a show.

As presently planned, a conference program of technical papers and discussions will be presented during the first two days, May 14 and 15. Exhibits, however, will be open the full four days.

Advance information on registration and hotel information can be obtained from the managers of the show, Clapp & Poliak Inc., 341 Madison Ave., New York 17.

Laminated Plastic Used As Commutator Insulator

PHILADELPHIA, PA.—A new laminated plastic has been found to be a good insulating material in commutators for dc motors and generators. Called APO-720, the material is a polyester-resin-bonded asbestos-paper laminate developed by National Vulcanized Fibre Co.

According to the company, the new laminate is being used in place of mica in automotive starter and generator commutators assembled by automatic machines. The flaking characteristic of mica often prohibits its use in automatic assembly machines. Plastic does not flake and also has good punching qualities.

Some of the specifications of APO-720 Phenolite are:

- Good arc resistance (181 seconds by test in accordance with ASTM D 495-48T)
- High dielectric strength (200 to 300 volts per mil)
- Nonflowing under pressure at elevated temperatures (compression set 5 to 7 per cent after 4 hours at 374 F and 1000 psi load)
- Density about 25 per cent less than mica (1.80 to 1.91)

Sheets or finished pieces of the laminate are available to manufacturers' specifications. Cost of the plastic is said to be less than mica.

New research laboratories have been completed recently in south Pittsburgh by Jones & Laughlin

26 56

Announcing . . .

Publication Every Other Thursday in 1956

IN 1956, MACHINE DESIGN will increase frequency of publication to every other week. This new policy—a major advance in MACHINE DESIGN's 26-year history — has two purposes:

1. To provide a slimmer, easier-to-read magazine, and
2. To expand the total number of editorial pages over the year.

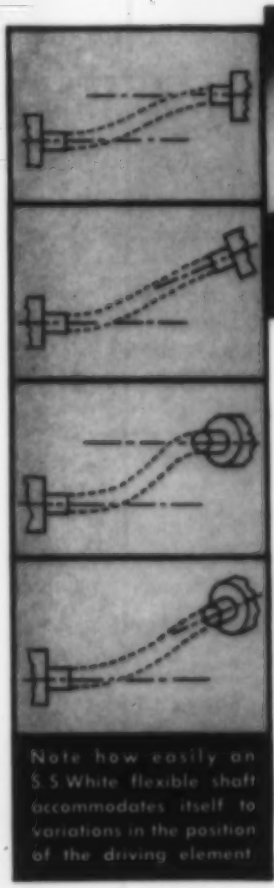
This change to biweekly publication has been prompted by the increasing size and complexity of design engineering—a trend which has been reflected by a large expansion in MACHINE DESIGN over the past four years. We believe that most readers will enjoy sitting down with a smaller magazine more often.

Each issue will be trimmed to a little more than half the current size. But with 26 issues per year instead of 12, the total editorial content will be greater. MACHINE DESIGN will be able to offer even more engineering assistance, with some room for additional expansion as the field of design engineering continues to grow.

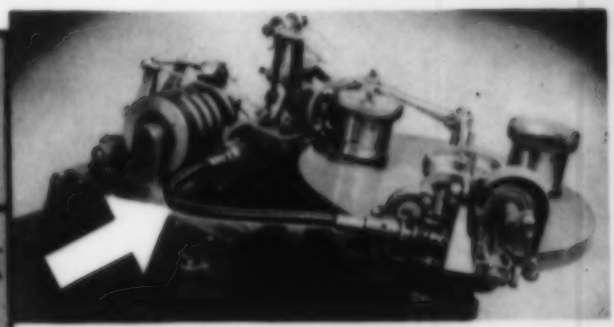
Every Two Weeks Starting January 12

S.S.White
FIRST NAME IN
Flexible
Shafts

Look how easily and economically these METAL MUSCLES® solve power drive alignment problems



Note how easily an S.S.White flexible shaft accommodates itself to variations in the position of the driving element



The non-rigid construction of an S.S.White flexible shaft automatically compensates for misalignment – allows the shaft to be run around turns, over or under obstructions – does away with the need for complex gearing systems, universals, etc. – eliminates the operational difficulties experienced with rigid couplings – and saves valuable assembly time spent in aligning the coupled parts.

Engineering cooperation in applying these versatile "Metal Muscles" to your own equipment is always available. Take advantage of it. There's no obligation.

Flexible shaft information for you...
Bulletin 5306 has basic information and data on flexible shaft selection and application. Send for a copy. Address Dept. 4.

S.S.WHITE INDUSTRIAL DIVISION 10 East 40th Street, New York 16, N. Y.

S.S.White FIRST NAME IN FLEXIBLE SHAFTS

F-9

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Reduced down-time and repair bills . . . longer machine life . . . increased production . . . elimination of costly hand oiling, and product spoilage due to over-lubrication are only a few of the benefits derived when a Bijur System becomes your "silent partner." Every bearing gets just the *right* amount of clean oil at the *right* time . . . automatically, while the machine is running.

Learn how inexpensive it is to start saving—the Bijur way. Write today for all the facts! © 1937

P-4

BIJUR

LUBRICATING CORPORATION
Rochelle Park, New Jersey

Pioneers in Automatic Lubrication

News Roundup

Steel Corp. The new facilities, costing $1.5 million, are named for Herbert W. Graham who in 40 years service with J & L became its vice president for research. The buildings have about 40,000 square feet of floor space and include a 3500-volume library.

"Just what's so hard about designing a machine to shape, mill, bore, tap and chamfer a piece in one operation?"

Low Expansion Alloys Announced

Studies Reveal Critical Chromium Content

WASHINGTON, D. C.—Certain cobalt-iron-chromium alloys have been found to have extremely low thermal expansion in the range between 20 and 60 C. This information is the result of thermal expansion and phase transformation studies on a number of these alloys by Peter Hidnert and Richard K. Kirby of the National Bureau of Standards. These findings are expected to be of interest to designers of equipment in which thermal expansion is important.

Scientists and engineers require low-expansion materials for applications in certain tools and machines. These include thermostats and measuring devices where some dimensional changes due to changes in temperature must be kept small. Generally fused quartz, in-

MACK TRUCK *Specifies* EPCO INVESTMENT CASTING *for Vital Part*

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"EPCO Cast lever used by Mack Diesel trucks and buses on hydraulic governor control."

INVESTMENT CASTINGS IN ANY CASTABLE ALLOY EXCEPT MAGNESIUM

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EPCO Cast in SAE 1045 steel ready for use except for tapping of ¼-20 thread, the lever was made at less cost and well within Mack's high quality standards.

EPCO Cast levers have been in constant use since 1947, and have performed with the same rugged dependability expected in a Mack Bus or Truck.

Get an EPCO quotation before machining or assembling your intricate parts.

Ask about our Vacuum Casting Process for increased quality control

EPCO ENGINEERED PRECISION CASTING CO.

Box MD 68 **Matawan, N. J.**

var, and some ceramics are used for such purposes. Of these, only invar is metallic, and it is subject to small but significant dimensional changes over long periods of time.

The Bureau's investigation indicates the existence of an alloy (approx 36.6 Fe, 8.9 Cr, bal Co) with a coefficient of expansion less than 1×10^{-6} per degree C for the range from 20 to 60 C. However, it was found that the low expansion of such alloys is very sensitive to small variations in their chemical composition. Also, some of them undergo a transformation on cooling at low temperatures.

The NBS experiments covered the temperature range from −196 to 1000 C. Measurements were made on 19 samples, 30 cm in length, with iron contents varying from 36.2 to 37.2 per cent and chromium contents varying from 8.6 to 9.9 per cent by weight. Linear thermal expansion of the alloys over the range from −65 to 800 C was determined with precision micrometric apparatus.

An electric furnace, in which the sample is surrounded by air or an inert gas, was used to obtain temperatures between 20 and 800 C. A stirred-liquid bath was used for temperatures between −65 and 300 C. Temperatures below 20 C were obtained by expanding compressed air from a liquid-air interchanger through coils immersed in the bath.

The effects of various heat treatments from −196 to 1000 C on the phase changes were studied with the aid of micrographs and by measuring the dimensional changes with micrometers and the expansion apparatus.

Of the samples investigated, those with chromium contents ranging from 8.6 to 9.2 per cent have very low rates of expansion around room temperature. In fact, some of these alloys have coefficients of expansion less than those for fused quartz and ordinary invar between −65 and 60 C. However, on cooling to lower temperatures they undergo a first-order transformation of the martensitic type. This results in a low-temperature phase that has a very much higher rate of thermal ex-

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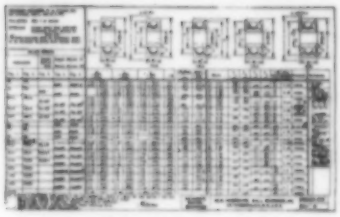

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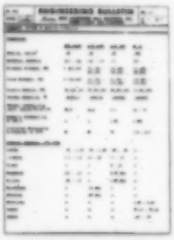

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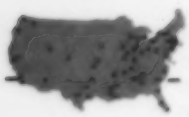

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pansion than the original high-temperature phase up to 200 C. The temperatures at which these transformations start were found to be as high as −10 C and decreased with increasing amounts of chromium content. The change in crystalline phase proceeds with audible clicks and slight increases in temperature. A needle-like martensitic structure is finally produced. The reverse transformation, which reproduces the high-temperature phase, starts at about 600 C but is not complete until the material is heated above 900 C.

Gas Turbine Powers Small Boat

Navy Personnel Boat To Test Turbine Power

SAN DIEGO, CALIF.—A small Navy personnel boat is being powered by a 500-hp gas turbine. According to Solar Aircraft Corp., makers of the turbine, tests are to be conducted to evaluate the feasibility of using a gas turbine power plant of this size for small craft propulsion.

Weight of the turbine is less than one-fourth that of a comparable marine engine. It is a variable-speed type weighing about 1000 lb including reduction gearing. Rotor speed is about 20,000 rpm.

Engine power output may be varied without affecting the compressor speed, according to the company. In the Solar engine being used in this application, two stages of the three-stage turbine drive the compressor unit, while the third stage drives the power shaft.

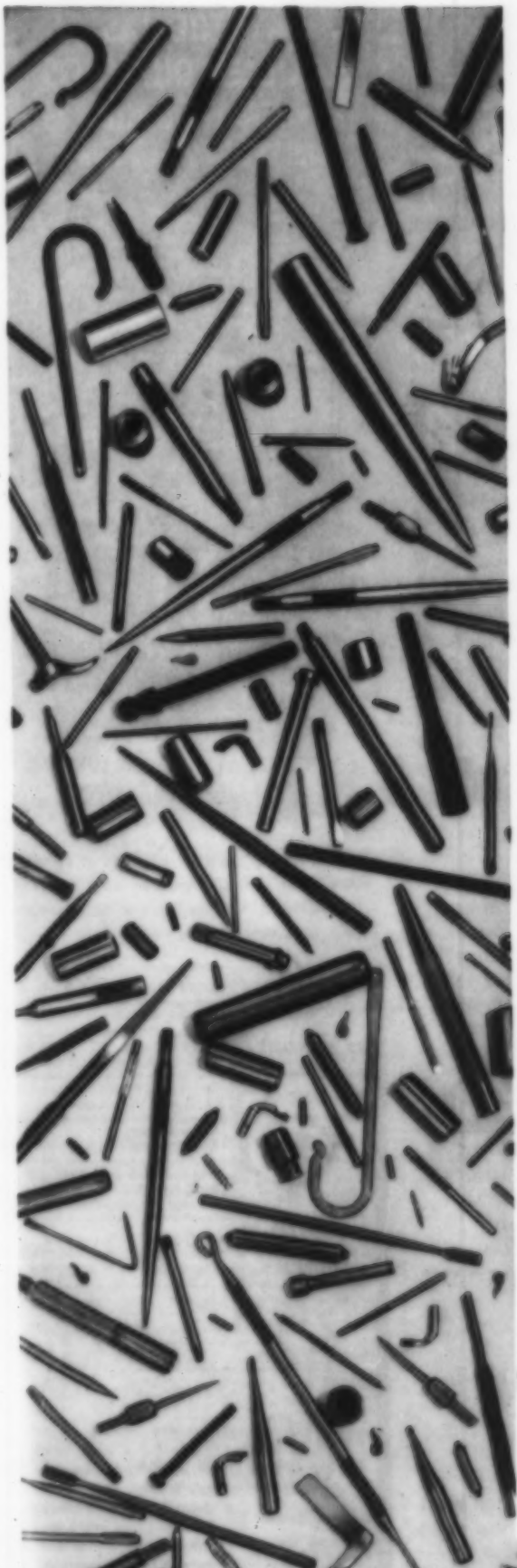
Among the advantages of the gas turbine is its ability to operate on a variety of fuels. No circulated cooling water is required, making the engine less vulnerable to damage from corrosion and broken piping and connections. Vibration is considerably less than that encountered in a conventional piston type engine. Light weight of a turbine power plant is expected to make it possible to power small craft at increased speeds.

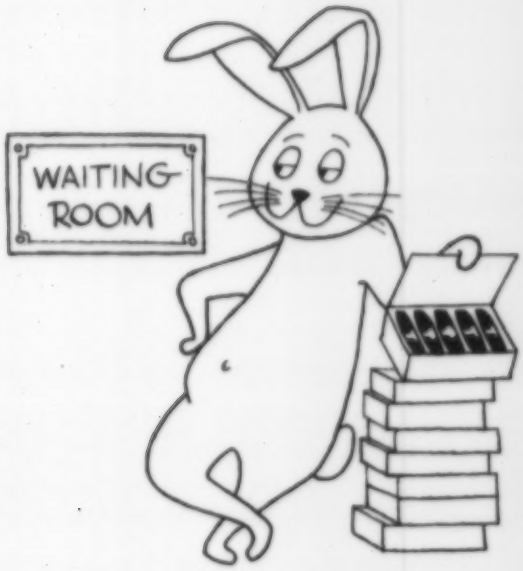
Gas-turbine powered boat shown here is undergoing tests to evaluate small craft propulsion with gas turbine power plants. A 500-hp Solar gas turbine weighing about 1000 lb drives this 40-ft craft

New Electrical Insulating Material Type Announced

WILMINGTON, DEL.—A new family of acrylic plastic electrical insulating materials has been announced by E. I. DuPont de Nemours & Co. Reported to be highly resistant to solvents, oils and refrigerants, the material can be used as insulation for electric motors.

Called "Lecton," the resin may be applied to glass fabric or compounded into a wire enamel. As a wire enamel, coated-glass fabric, or laminates of coated-glass fabric, the insulation is reported to withstand temperatures above 130 C. They can be used intermittently at temperatures up to 150 C. Dielectric properties of these acrylic materials are essentially unaffected





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TORRINGTON SPECIAL **METAL PARTS**

Makers of Torrington Needle Bearings

HEAT TREATING as an INDEX

J. G. Bourne

CHAIRMAN, THE CINCINNATI GEAR CO.

The continuing demand for improved quality in gearing used throughout industry is closely reflected, we think, by the yearly increase in the percentage of our gear output that is scientifically heat treated and specially hardened. This constant pressure for better, tougher, quieter gears carries over into all phases of their manufacture. Gone are the days when a gear was simply any old blank with some teeth cut in it. Even in the past 15 years the change has been dramatic. The necessity to meet steadily increasing requirements in pitch line velocity and stresses has dictated better steels, closer tolerance, more critical tempering and hardening.

Heat treating is, in fact, one of our fortes. We have in conjunction with our modern gear manufacturing facilities a complete heat treating plant second to none in the gear industry. Because we are not dependent on outside sources for our heat treating, we obtain obvious advantages in delivery and cost as well as in quality. This is one big reason why we have earned such an enviable reputation for consistently high quality custom gear work, regardless of the requirements. And it is a typical indication of our continuous year-in and year-out efforts to supply gears that meet industry's most exacting demands.

THE CINCINNATI GEAR CO.

CINCINNATI 27, OHIO

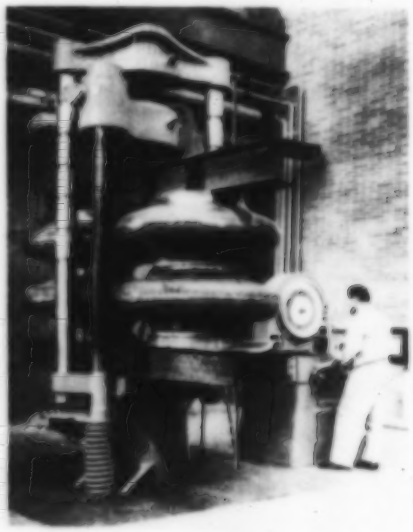
"Gears — Good Gears Only"

CINTI

News Roundup

by high relative humidities.

At present in the pilot-plant stage, glass fabric coated with Lecton is being offered in experimental quantities. Laminates of various thicknesses are available in test quantities as slot liners, wedges and coil separators.



BIG BELLOWS are being tested at 100,000 psi on a Baldwin - Lima - Hamilton universal testing machine at C. F. Braun & Co., Made of ¾-in. low - carbon steel plate, each bellows has an inside diameter of 25 in. with a 10 in. offset. Outside diameter is 46½ in. The bellows are designed to compensate for expansion in chemical plant or oil refinery processing units

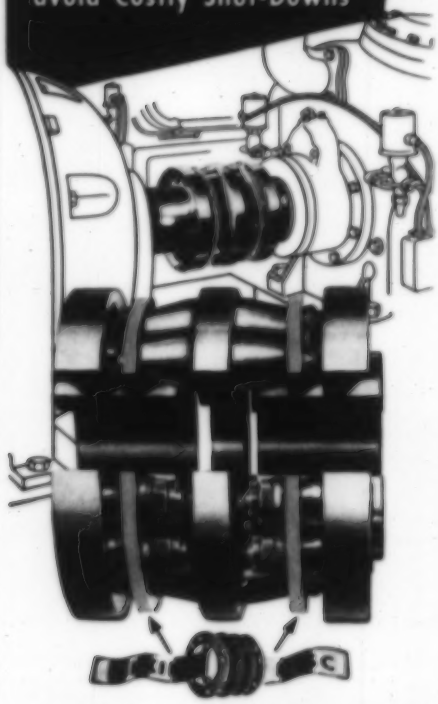
Upside-Down Welding Improves Stainless Tubing

New Process Eliminates Internal Weld Bead

PITTSBURGH, PA.—Gravity has been put to work to eliminate the weld bead inside stainless or high-alloy tubing. A newly patented process developed by Trent Tube Co. welds the formed tubing from the underside. Even in the as-welded condition, says the company, the tube has a perfectly smooth and

Specify THOMAS ALL METAL **FLEXIBLE COUPLINGS**

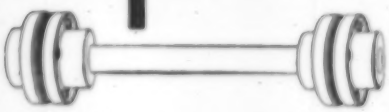
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.

WARREN, PENNSYLVANIA, U.S.A.

flawless interior surface.

By controlling the weld bead in this manner, many improvements resulted, both mechanical and metallurgical. Grooves, valleys or undercuts in the weld area after cold working or drawing are eliminated. A smooth, uniform outside surface finish is obtained similar to the surface of the parent metal, making it possible to reduce the weld bead by swaging.

Corrosion resistance has been improved because of the absence of valleys or grooves. There is no place for solids to deposit or corrodants to become entrapped.

Development of the new process, according to Trent, will enable investigation into many alloys never before furnished in welded tubing. Production of many alloys in a wider range of sizes will also be possible.

Practical Method Developed For Brazing Chromium Carbide

NEW YORK—A practical production method has recently been developed for brazing cemented chromium carbide with silver alloy filler metals.

The development, carried out at the Carboloy Dept. of GE in cooperation with Handy & Harman, is expected to pave the way for wider use of cemented chromium carbide for applications in the 600 F range, where the alloy could not be used heretofore for lack of a suitable joining method. Such uses include chemical and food equipment, valve components, high-speed instrument bearings and similar applications where good resistance to corrosion, abrasion and oxidation—particularly at elevated temperatures—is essential.

In the past, cemented chromium carbides have been successfully brazed in an atmosphere of pure, dry hydrogen or by using filler metals of high silver and manganese content. However, such methods have not been adaptable to economical production because of the special care required when the high-nickel sintered face of the chromium carbide is removed. The

(*Continued on Page* 36)

Factory pre-setting assures high accuracy . . . eliminates costly pre-installation adjustments

Cramer CYCLING TIMERS

The accuracy of a cycling timer depends on the exactness of the cam settings. If any one of the driving cams is incorrectly set, even to the minutest degree, the over-all program pattern or sequence of operations is changed.

Cramer cycling timers are normally supplied with all cams pre-set to customer specifications on special calibration equipment like that shown above. This pantographic principle, in effect, produces a sixteen-time enlargement of the cam, permitting extremely close setting accuracies.

While these timers can be adjusted in the field, factory setting assures highest accuracy and eliminates costly pre-installation adjustments.

This is but one of the many Cramer customer services designed to provide greater product usefulness and satisfaction at lower cost.

For full information about Cramer Cycling Timers, write for new Bulletin PB-510.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

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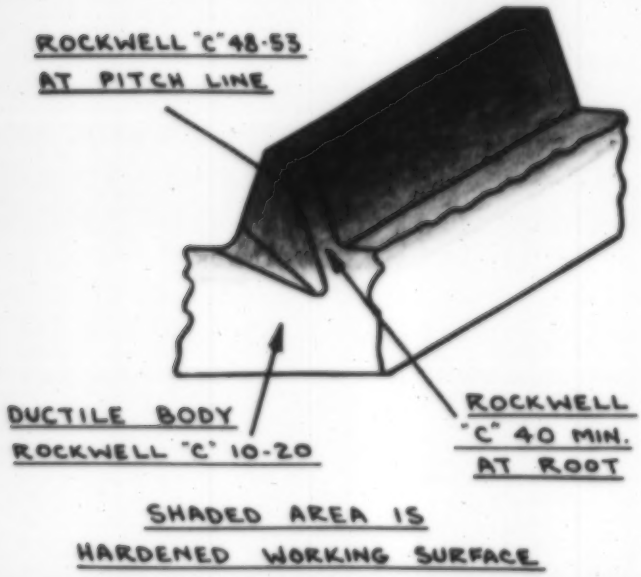
THIN! TOUGH! ...and "tender-hearted"



THE MANUFACTURE of flywheel ring gears poses special problems. Sectional thickness is usually less than three-quarters of an inch. To withstand the impact force of the starter pinion, the gear teeth must be hard. But the gear body itself should be unhardened so that it will conform tightly to the flywheel, and "give" under the stress that might snap a brittle gear.

Note how DOUBLE DIAMONDS are made to be thin, tough, "tender-hearted." The above photo of a gear twisted into a pretzel shape graphically demonstrates ductility. The sketch at right shows three important areas: the wide and deep hardness pattern, the generous area of transition, and the ductile body. These extremes are achieved in DOUBLE DIAMOND Flywheel Ring Gears by controlled selective heat treatment—all essential to flywheel ring gears that provide the best possible performance.

Our Engineering Department will be glad to make constructive suggestions on the design of flywheel ring gears, or on the many other types in which we specialize. Write, phone or wire—depending on the urgency of your need.

DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATION

GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

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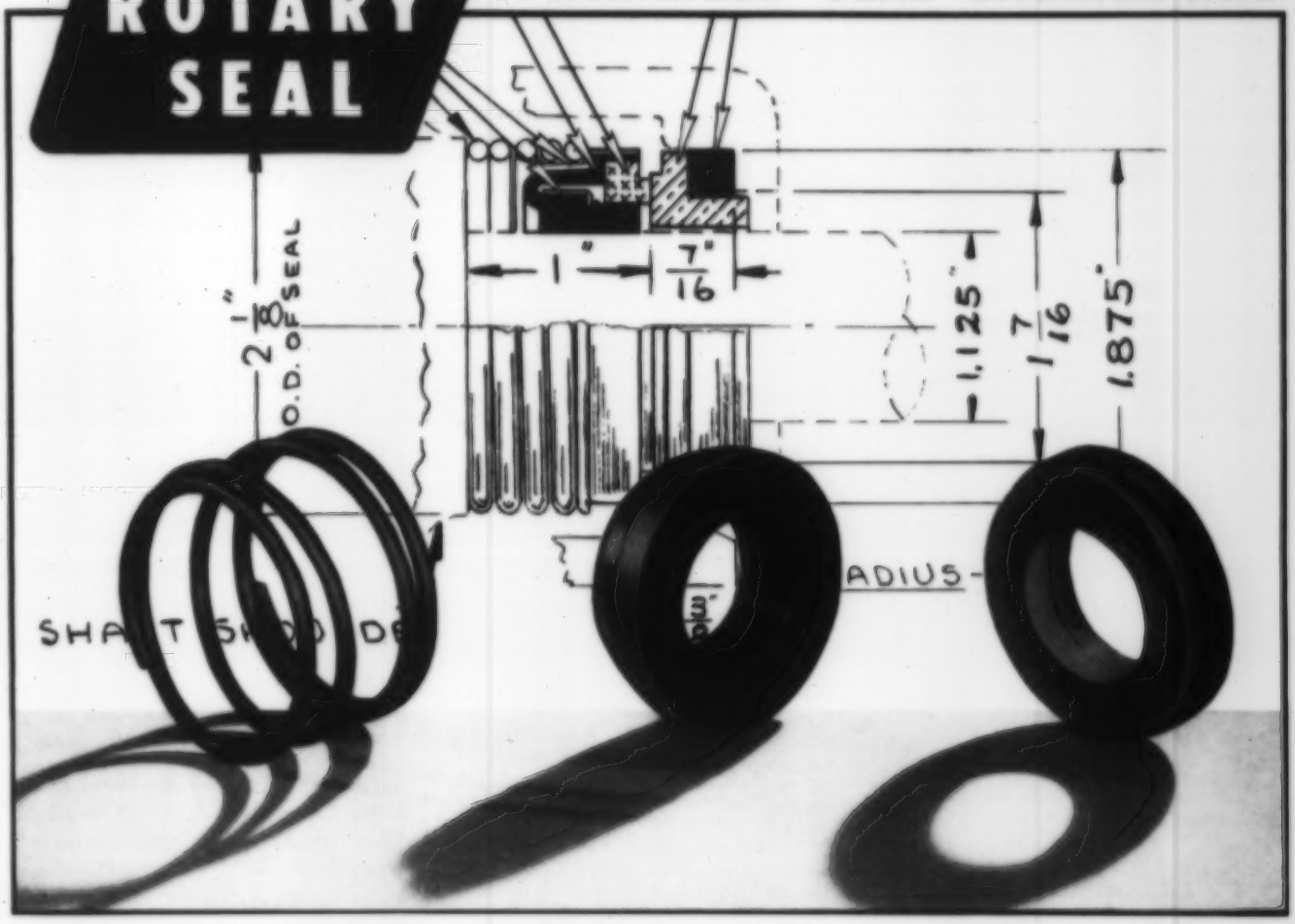
SPECIALIZED SEAL ENGINEERING



is developing new ways to assure top performance in DIFFICULT HEAVY-DUTY SEWAGE PUMP OPERATION

There are all sorts of pumps, for all sorts of purposes, and Rotary Seals of varying designs are in wide use along the whole range. But here's an application where the pump operates under some of the most extreme conditions you can imagine—in a heavy-duty sewage system. Often, the pump is completely drowned while working; and the kind of flowage it must handle offers difficulties of its own.

The Shaft Seal—at the operating heart of the pump—must obviously be built to "take it"—and keep on taking it, because constant maintenance or repairs are inconceivable under the circumstances. And, as so often is the case when the assignment is tough, it's a Rotary Seal (*custom-designed* to meet the unusual conditions) which is doing the job. That's our business: solving hard Shaft Sealing problems by applying the basic Rotary Seal principles which opened the way to successful mechanical Shaft Sealing when this company introduced them years ago.

Major assignments for important Seal developments are keeping us mighty busy at present; but if special difficulties are besetting your development programs, and production quantities of Seals are involved, we'll be glad to help if we can.

THE ROTARY SEAL COMPANY

mechanical seals for rotating shafts

Shaft-Sealing with Certainty

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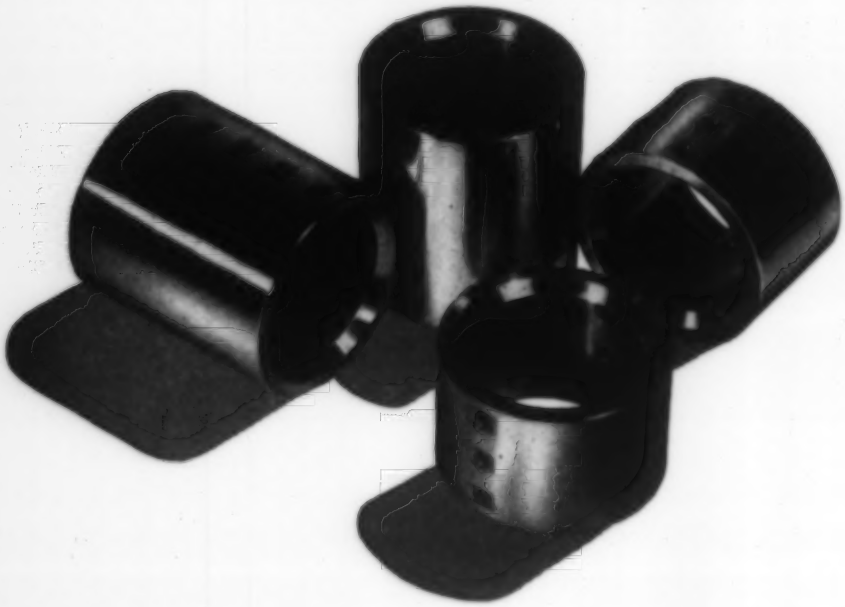
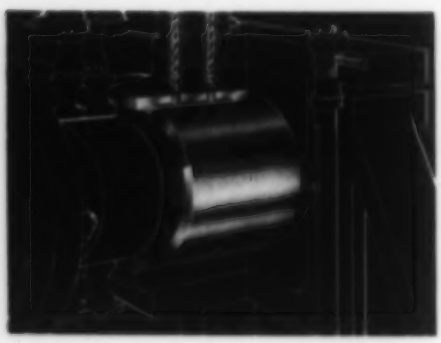
Consider your customer...

IN BEARING SPECIFICATIONS



Disassembly and removal of the original bearing and reassembly with a new bearing are inevitable at some time or other in the life of every machine. The frequency and cost of such service is a big consideration in the mind of your customer. The cast Bunting Bronze Bearing gives you maximum of bearing performance and life with far less costly and laborious replacement than any other type of bearing.



Designs like this present no production nor replacement complications. Bunting engineers will gladly collaborate with you in a study of your bearing requirements. There is a Bunting engineer near you, or write our Products Engineering Department at Toledo.

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THE BUNTING BRASS AND BRONZE COMPANY, TOLEDO 1, OHIO
BRANCHES IN PRINCIPAL CITIES • DISTRIBUTORS EVERYWHERE

News Roundup

(*Continued from Page 31*)

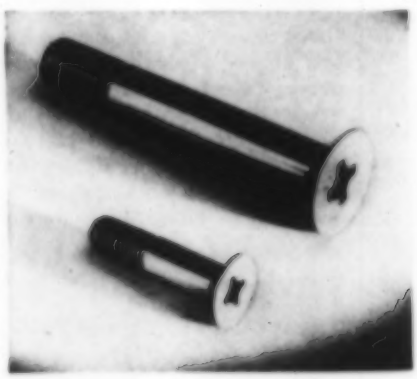
new process, worked out with Carboloy grade 608 cemented chromium carbide, now makes it possible to braze these alloys in air without special equipment, using one of several commercially available silver-alloy filler metals.

The technique is based on the use of a brazing flux containing powdered boron. Boron, being a strong reducing agent, appears to have outstanding ability to dissolve the characteristically tough chromium oxide film encountered in chromium carbide and the flux was found to promote good wetting and bonding.

Flush-Head Bolts Made of Titanium Alloy

Substitutes for Steel Can Save Weight in End Products

PHILADELPHIA — Flush-head shear bolts have been made of titanium alloy recently by the Standard Pressed Steel Co. The titanium bolts are intended to replace stainless steel bolts size-for-size in end products and thereby provide appreciable savings in gross weight. The new 100-degree flush-head



bolt is an NAS 333 series type aircraft fastener made in sizes ranging from ¼ to ½-in. diameter. The titanium alloy contains 4 per cent aluminum and 4 per cent manganese. The same bolts made of stainless steel weigh 75 per cent more than the new titanium counterparts.

In SPS laboratory tests the ¼-in. and ⅜-in. diameter titanium bolts had shear strengths of 113,470 psi and 108,695 psi respective-

ly—well above the minimum 95,000 psi required for this type of fastener.

In tension-tension fatigue tests the ¼ and ⅜-in. diameter bolts had endurance limits of 55,000 and 40,000 psi, respectively. Limits of 20,000 psi are required for both sizes. Tension-tension fatigue data in the range of 6000 to 60,000 psi will be supplied with each lot produced.

The same company also produces titanium tension bolts of the MS 20004 series type and titanium shear bolts of the NAS 464 series type.

40 Per Cent of Industrial Managers Engineer-Trained

Illinois Tech President Cites Student Shortage

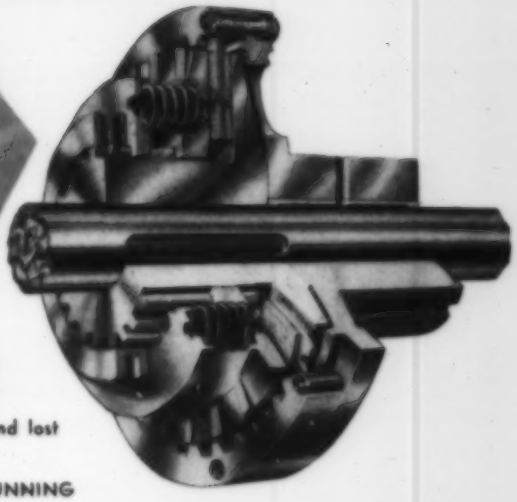
CHICAGO—The engineer is rapidly replacing the lawyer and the banker in top management positions in industry, according to Dr. John T. Rettaliata, president of Illinois Institute of Technology. Speaking at the annual meeting of the American Society of Safety Engineers, Dr. Rettaliata said that as policy problems grow more complex the engineer is being called upon to assume functions beyond the scope of engineering. He cited a survey to the effect that 40 per cent of today's industrial management is engineer-trained.

Dr. Rettaliata asserted that the trend toward increasing managerial responsibilities for engineers calls for a broadened education to encompass training in fields other than the engineer's speciality and continuous replenishment and expansion of the ranks of the profession. "The young engineer," he explained, "must be made aware of the cost factors in productivity, the labor factor, and marketability. He must be made conscious of consumers, advertisers, suppliers, and customers."

Citing a demand for more engineers, Dr. Rettaliata said there is "urgent" need for interesting more qualified high school graduates in careers in engineering and science. He pointed out that only six out of every ten of the top-

HILLIARD Clutches
FOR POWER CONTROL DESIGN

ADJUSTABLE
Slip Clutch



- PROTECTS against overload, jams and down time.
- RESUMES THE DRIVE AUTOMATICALLY after overload.
- ELIMINATES SHEAR PINS and lost time.
- ADJUSTABLE - WHILE - RUNNING feature is available.

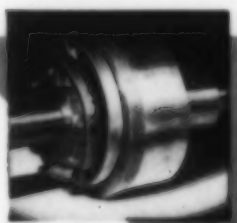
Hilliard Slip Clutches are continuously protecting the drive on dish washing machines—printing presses—packaging machines—case loaders—foundry equipment— air filters—conveyors—overhead doors—and many others.
They maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

The adjustable-while-running types are used to maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

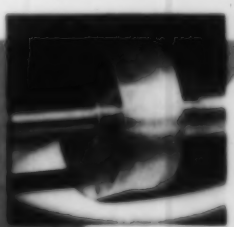
WRITE TODAY FOR BULLETIN 300 WITH COMPLETE INFORMATION.

● OTHER HILLIARD CLUTCHES ●

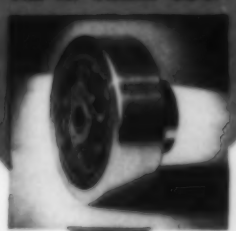
CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-2.



SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.



OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet, or backstop action. Ask for Bulletin 231.

THE HILLIARD Corporation
MANUFACTURING CLUTCHES FOR OVER 50 YEARS

101 WEST FOURTH ST., ELMIRA, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

VIBRATION-DAMPING

SHOCK-ABSORBING

SKID-PROOFING

CUSHIONING

NOISE-KILLING

SCRATCH-PREVENTION

GLAZING STRIP

SCRATCH-PREVENTION

General Electric use small pads of Armstrong DK-153 Tape to make sure their light boxes won't scratch desk or table tops. This resilient, cork-and-rubber sponged-rubber material does a good job of absorbing shocks and preventing skids, too.

DK-153 is easy to apply—it's backed with a tacky adhesive that sticks to almost any clean, dry surface. You can get it in tapes, rolls, sheets, or die-cut shapes in many widths and thicknesses. For samples, write on your company letterhead to Armstrong Cork Company, Industrial Div., 7312 Dean St., Lancaster, Pa.

Armstrong DK-153 TAPE

. . . used wherever performance counts

News Roundup

ranking 5 per cent of high school graduates go to college, and said that this was a tremendous loss to engineering and to other fields as well.

Dr. Rettaliata urged engineering societies and industry to promote and provide financial assistance through scholarships to brilliant secondary school students so that they can pursue their education at the higher level in institutions of their choice.

Conservation of the country's material resources also is a responsibility of the engineering profession, Dr. Rettaliata stated.

"It is hard," he said, "for Americans, long accustomed to ideas of boundless American resources, to think of ourselves as a nation whose resources are running out.

"Yet in ever-sharper measure our attention is being called to the growing problem of shrinking stores of natural material wealth. The time has come when we must be truly scientific about the utilization of our resources."

Engineering is entering an era of achievement that "will dwarf prior accomplishments" because of the rapidly rising population, the exploitation of new areas of scientific development, and the necessity to advance the country's technology as the foundation of national defense.

Piasecki Helicopter Corp. announced that its board of directors has adopted appropriate resolutions recommending that the name of the company be changed to **Vertiplane Corp.** The name change, which has been under consideration for several months, was made to identify the firm more fully with the broad field of vertical flight, which includes, in addition to helicopters, VTOL (vertical take-off and landing) aircraft, and convertiplanes (aircraft that take off and land as helicopters, but fly as conventional aircraft).

Admiral Corp. announced the start of a new electronic research laboratory to be situated on a three-acre site in Stanford Industrial Park at Palo Alto, Calif. The

new laboratory will provide facilities for the expansion of Admiral's Advanced Development Section. According to the announcement, the building will house precision equipment and other scientific apparatus required in research and development work on military projects in the fields of guided missiles, radar, systems, air navigation, nuclear radiation measurement, direction finding and communications, as well as on the company's civilian products.

Navy Service "C" fractional-horsepower motors, especially designed for marine applications, have been announced by the General Electric Company's Specialty Component Motor Department.

The spraytight, totally enclosed motor is built with varnish-impregnated windings and cords, corrosion-resistant hardware, and a welded steel base. Recommended for nearly all marine auxiliaries above and below decks, the motor is claimed to meet all design and material requirements for Service "C" motors under specifications MIL-M-17556.

The motor has double-sealed, double-width, single-row ball bearings. One bearing is locked on the shaft; the other bearing is locked to both the shaft and housing for minimum end play.

Designated Type BC Navy Service "C", the motor is available in speeds of 3450, 1725, 1140 and 860 rpm and ratings of 1/20 through one hp. Starting torque is rated in excess of 300 per cent of full-load torque, and starting current is approximately 500 to 1000 per cent of full-load current.

Rubber Impregnation Improves Vulcanized Fiber

WILMINGTON, DEL.—A new material, created by sizing vulcanized fiber with oil-resistant rubber, may open up several new fields of application. With a higher compressibility and friction coefficient than standard vulcanized fiber, the rubber-sized vulcanized fiber seems to have possibilities for gasketing

(*Continued on Page 42*)

From DIALCO—New, Compact

OIL TIGHT

INDICATOR LIGHTS

for heavy duty industrial applications

OIL TIGHT
DUST TIGHT
OMNIDIRECTIONAL

Exceptionally Rugged!

Perfect oil-tightness is effected by retained oil-proof gaskets and the gasketed glass lens assembly.

These units have many heavy-duty features: *One-piece solid brass bushing, solid brass lens holder, high impact phenolic insulation, rugged binding screw terminals.*

They install easily in a single 1" or 1 3/16" panel mounting hole. Other units available for 1 1/16" mounting hole. *A choice of 3 lens styles, 7 lens colors,* and other optional features provide adaptability. If you have an unusual problem, consult our engineering department.

DISCS with legends, behind flat lenses, deliver specific messages.

DIALCO

OIL TIGHT INDICATOR LIGHTS

accommodate a wide range of Incandescent and Neon Glow Lamps. For neon, DIALCO offers an exclusive feature — *BUILT-IN RESISTORS* (U. S. Patent No. 2,421,321) for operation on 105-125 V, or 210-250 V. Simple external resistors are provided for all higher voltages. *EVERY ASSEMBLY IS AVAILABLE COMPLETE WITH LAMP.* For design purposes we will send:

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

CATALOG "L-200" gives you complete specs on DIALCO'S Oil-Tight Indicator Lights. Also available—a file of Special Catalogs on DIALCO Pilot Lights covering every indication requirement.

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MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

Does YOUR design

Let MICRO SWITCH Engineering help you selec

ENCLOSED LIMIT SWITCHES

Heavy duty

Explosion-proof

Small 2-circuit

Roller arm sealed plunger

Roller arm explosion-proof

Plunger actuated

Hand operated

Roller plunger operated

Sealed plunger

Send for new Catalog 83 for complete description of a wide variety of enclosed switches for industrial use.

call for an enclosed switch?

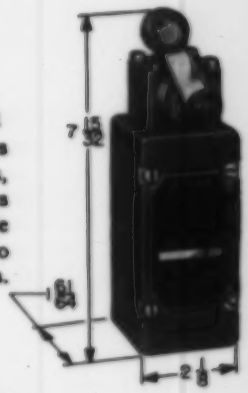
the precision switch for your application!

MICRO SWITCH enclosed precision switches afford the design engineer a wide choice of types to meet most exacting requirements. Shown here are a few of the many types of MICRO SWITCH enclosed switches. They are available in a wide variety of circuit arrangements and actuating mechanisms.

Is your equipment to work in atmospheres laden with dust, dirt, moisture or abrasives? MICRO SWITCH provides both general purpose and limit switches sealed so as to be unaffected. Explosion-proof switches for hazardous atmospheres and splash-proof switches for conditions of extreme moisture may meet your design problem. Two decades of experience in meeting industrial precision switch problems is as close as your telephone.

MICRO SWITCH branch offices are located in 22 principal cities. These offices are staffed by factory-trained, experienced personnel. Their experience in solving every type of switching problem is available to you. A call may save you time and money by bringing a quick solution to YOUR design problem.

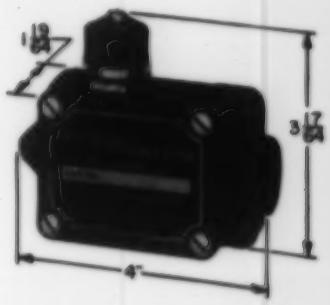
SMALL 2-CIRCUIT LIMIT SWITCH
For control of two independent circuits. Sealed construction, high electrical capacity and features of adjustability suit it to all types of industrial applications where space is limited.



EXPLOSION-PROOF LIMIT SWITCH
Suitable for use in hazardous atmospheres such as are present in chemical factories, refineries, flour mills, paint spray booths and metal processing plants. Available with roller arm actuator (shown). Also with pin and roller plunger actuators.

COMPLETELY SEALED CYLINDRICAL SWITCH
Developed for aircraft designs, this switch has greater versatility than switches many times its weight and size. Two single-pole, double-throw switching units are completely sealed in a housing filled with inert gas under pressure.

HIGH CAPACITY SWITCHES
Long-life precision switches will make and break steady state currents of 20 amperes and switch inrush currents as high as 75 amperes. Shown with sealed plunger actuator for in-line operation. Also available with roller arm actuators.



A complete line of snap-action and mercury switches

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

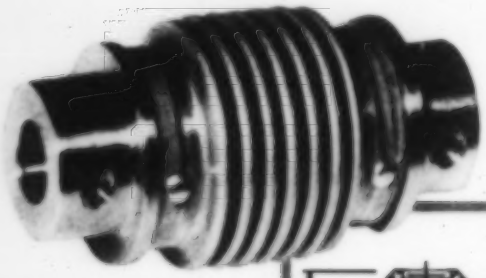
MICRO SWITCH

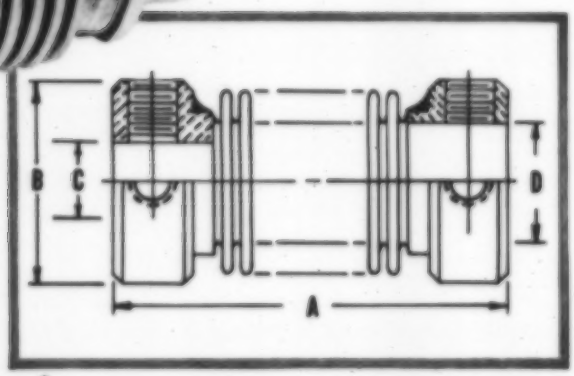
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

FLEXON BELLOWS *Design Briefs*

How to Select and Specify Flexon Bellows for Use in Low Torque Couplings





FLEXON OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel for vacuum equipment, thermostatic devices, pressure controls, packless valves, pneumatic instruments, hydraulic mechanisms, rotating shaft seals and many other services.

The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

Flexon Bellows offer the designer an economical means of coupling shafts when torque is low. The inherent flexibility of the bellows compensates for angularity and misalignment at a cost well below conventional methods.

However, because of the torque limitations certain basic considerations are necessary:

Allowable O.D. of bellows and/or shaft fittings
Allowable overall length including fittings
Maximum torque on bellows
Maximum misalignment
Frequency of rotary motion
Temperature range

With this data, Flexonics can develop bellows type couplings to fill a wide variety of needs, economically. Submit the data outlined above and Flexonics will design the bellows coupling to meet your requirements.

Flexonics *Corporation*

FLEXON BELLOWS DIVISION

1339 S. THIRD AVENUE • MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 10 years.

News Roundup

(*Continued from page 39*)

and as a packing and facing material.

In the special grade announced by National Vulcanized Fiber Co., the Hycar rubber is dispersed throughout the fiber. Since it does not have a surface coating to wear off, the material is considered particularly suited for abrasion-resistant uses. Friction coefficient is 30 to 50 per cent higher than standard vulcanized fiber, and chemical resistance is said to be improved.

Compared to vulcanized fiber, rubber-sized fiber is about 70 per cent more compressible and 69 per cent more resilient—properties of advantage in gasketing applications. The fiber is supplied in thicknesses from 0.015 to $\frac{3}{8}$-inch.

No Need to Shout

New Phone Amplifier Is Compact and Versatile

SAN FRANCISCO—A new telephone amplifier called "Scottie" has been introduced recently by the Remler Co., for phones in noisy locations or for people hard of hearing.

Weighing 3 ounces, the $2\frac{3}{4}$ in.

diameter Scottie Phone Aid fits over any commercial telephone. It is a reproducing receiver and three-stage amplifier using transistors and powered by miniature batteries. It is said capable of increasing acoustic output of telephones by 49 decibels.

The volume can be adjusted while "Scottie" is in use, and a switch on the device prevents battery drain when "Scottie" remains attached to a phone.

Corrosion-Inhibiting Gases Protect Turbojet Engines

Between-Flight Technique May Have Other Applications

CAMBRIDGE, MASS. — Arthur D. Little Inc. has revealed a process for reducing corrosion in turbojet engines. Theodore J. Mussdorfer, an A.D. Little engineering physicist, reported recently that the process employs corrosion-inhibiting gases sealed into a plane's engine upon return from a flight. The ends of the engine chamber are capped with air-tight plugs containing the gaseous components of the inhibitor which then reach all engine parts. Starting the engine clears out the compound. Other applications may be in the defense industry's layaway program for machine tools and in impregnated wrappings for large packages.

Minneapolis-Honeywell Regulator Co. recently announced plans for an expansion of its aeronautical engineering and research facilities in Minneapolis. Paul B. Wishart, president, said work would start immediately on the construction of a three-story, 45,000 square foot addition to the present aeronautical engineering building. Scheduled for completion in 1956, the new addition will increase by more than 30 per cent the space presently allocated for engineering and research work in the development of automatic controls and control systems for military and commercial aircraft and guided missiles.

Slotted and Recessed Head Tapping Screws and Metallic Drive Screws and **Machine Mounting Specifications for Abrasive Discs and Plate Mounted Wheels** are the subjects of proposed American Standards currently under prepa-

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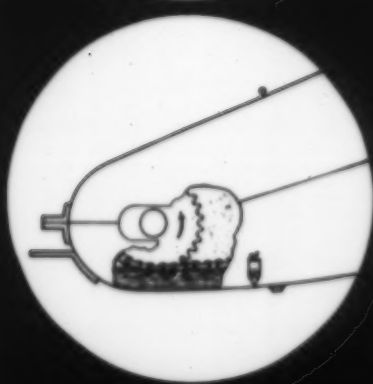


MANUAL, DRIP or IMMERSION?

Correct lubrication is essential to the long life of the chain drive. Mineral oils of varying viscosity are recommended. Methods of application are generally determined by the speed of the drive. Lubricants are applied by brush, immersion or by drip feed.

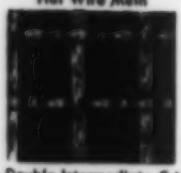
ACME'S Chain Engineers have the answers. They're yours for the asking. Whenever a chain problem arises, call in an ACME engineer . . . no cost to you! It's a part of ACME service.

FREE ACME CHAIN TEXT!

Designers and engineers may write for a free copy of this 76 page chain text. It's loaded with chain data, specifications, illustrations and facts you should know about chain applications. Write ACME CHAIN CORP., Dept. 6B, Holyoke, Mass.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Flat Wire Mesh


Double Intermediate Crimp

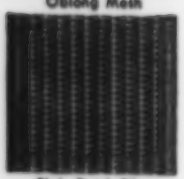
Single Intermediate Crimp

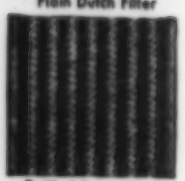
Double Crimped

Twilled Weave

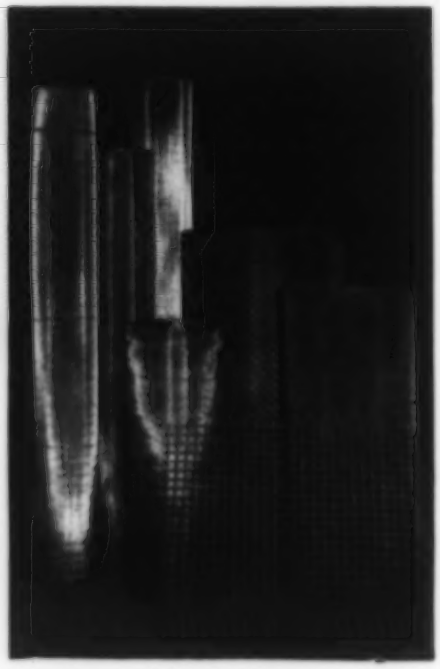
Calendered Backing

Oblong Mesh


Plain Dutch Filter


Twilled Dutch Filter

need WIRE CLOTH in a hurry?



call *Cambridge* for shipments FROM STOCK

COMPLETE LINE—Cambridge stocks include a wide variety of specifications from the finest to the coarsest mesh in any metal or alloy.

QUALITY—Accurate mesh count and uniform mesh size are assured by individual loom operation and careful inspection just before shipment.

PROMPT SERVICE—You get immediate delivery on large or small orders for the most frequently used types of cloth. If your needs are not in stock, we'll schedule our looms to get your material to you without delay.

CAMBRIDGE ENGINEERS, in the home office and in the field, are fully qualified to help you select weaves, mesh sizes and metals to meet your needs.

IF YOU NEED SPECIAL WIRE CLOTH FABRICATIONS—

Strainers, screens, filter leaves, etc. . . . we can build them quickly and accurately from your prints. . . . or, our engineers will draw up prints for your OK.

LET US QUOTE *on your next order for wire cloth in bulk or fabricated wire cloth parts. Call your Cambridge Field Engineer—he's listed under "Wire Cloth" in your classified telephone book.*

OR, WRITE DIRECT for FREE 80-page CATALOG and stock list giving full range of wire cloth available. Describes fabrication facilities and gives useful metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department N,
Cambridge 12,
Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

News Roundup

ration. Tentative drafts of each of the standards have been distributed recently by the American Society of Mechanical Engineers for criticism and comment. Interested parties may obtain copies free of charge by addressing Frank Philippbar, Standards Dept., ASME, 29 West 39th St., New York 18.

Magnetic Field Makes Real Cool Refrigerator

CAMBRIDGE, MASS.—Extremely low temperatures in the range of absolute zero (−459.6 F) are achieved by a refrigerator controlled by magnetic fields. Although the principle of magnetic cooling is not new, the unit developed by Arthur D. Little Inc. is the first to maintain these temperatures for long periods of time.

There are no moving parts or flowing liquids in the cooling system. Instead it uses a 3-inch long capsule containing a chemical salt. This material warms up when magnetized and cools when demagnetized.

Studies of atoms and molecules of certain materials are expected to be made easier at these sustained low temperatures. Movement of these bits of matter at ordinary temperature makes their

measurement difficult. Low temperatures near absolute zero slow these particles down.

Strong Adhesive Developed For Mass-Production Joining

Thixotropic Epoxy Paste Used Direct from Container

BLOOMFIELD, N. J.—Permitting economical bonding in mass production, a new high-strength epoxy adhesive is claimed to be the first one-part paste available. Since mixing of two components — a usual procedure with epoxy adhesives—is eliminated, the new single-component adhesive can be used right from the container. No special measuring, weighing or mixing procedures are necessary.

Thixotropic nature of "Bondmaster 260," developed by Rubber & Asbestos Corp., results in a complete absence of drip or "run" either before or during cure. Thickness of the glue line laid down before curing, whether 0.001 or ½-in., remains the finished glue line thickness after curing. The adhesive may be applied in a vertical position, and the part jigged at right or acute angles with the finished bond retaining the assembly in that exact position.

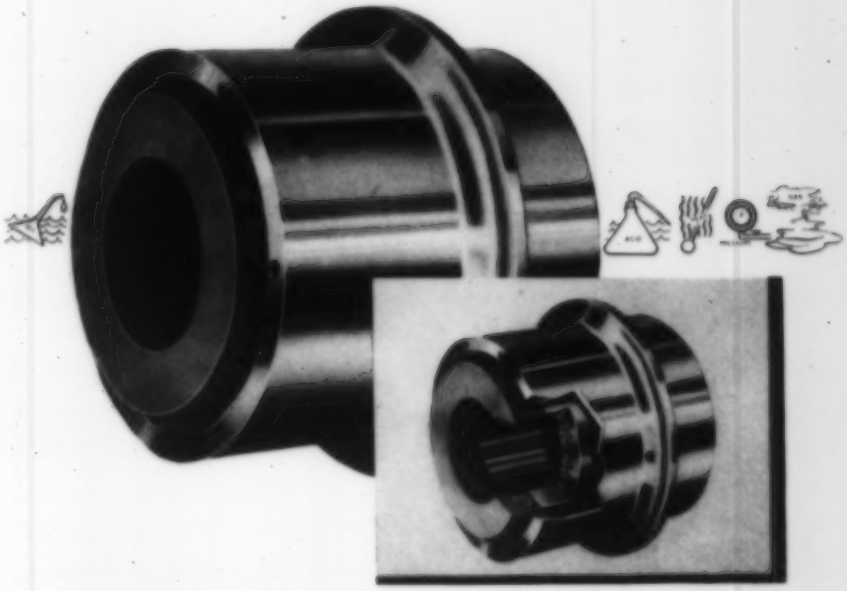
Added advantages of a thixotropic material of this type lie in usage of the adhesive for "poor fit" and similar void-filling applications, as well as where unsightly dripping or running of adhesive must be controlled. Postcleaning of bonded parts, it is reported, is eliminated completely.

Bendix Aviation Corp., Scintilla Div., has announced a $2 million expansion. Engineering design, research and laboratory and experimental machinery facilities will be consolidated in a new engineering building.

Ferro Corp. has announced plans for a new $350,000 engineering facility. The new two-story structure will house the Ferro Engineering Div. and the Allied Engineering Div., announced board chairman R. A. Weaver.

(Continued on Page 48)

SPECIAL



nothing can touch this winding

Oil, acid, vapor, heat and pressure don't affect this AC motor winding. It's completely encased in a special, high-temperature, chemical-resistant plastic. The windings are cast right in the plastic to make a single, solid, impervious piece.

Of course, this winding goes into a special motor — one that's designed to run in a pressurized atmosphere of inert gas, under constant exposure to a piping-hot oil splash and vapor at over 200°F. Temperature-stabilized bearings, oil lubricated under pressure, and drip-proof, corrosion-resistant construction are some other design necessities for this unique 115-volt, 1/3 hp AC motor.

Here is a typical example of ESCO's unusual ability to design and build rotary electrical equipment to meet special customer needs. Whether or not your particular motor problem is this special, remember that ESCO's twenty years of broad experience is always available to you. No motor or generator problem is too big or small, too routine or specialized for ESCO engineers and craftsmen to solve properly, the way you want it solved.

Refer to Esco Catalog in section $\frac{4a}{E1}$ in Sweet's Product Design File, or write direct for general catalog No. 56PD. Why not also send us details on your special problem . . . we'll be glad to show you how we would go about solving it for you.

ESCO ELECTRIC SPECIALTY CO.
179 South Street, Stamford, Conn.

"V-V" Golf Grip molded for **The Kroydon Co.**, Maplewood, N. J., by **Hungerford Plastics Co.**, Rockaway, N. J.

This "professional" golf-grip demonstrates the performance features of BAKELITE Brand Elastomeric Vinyl Plastic VYNW, the material from which it's molded Attach it to your golf club, and the correct grip is built-in. The club is always held in the right position—every finger in the right place, snugly fitted into the molded grooves

The long-lived resiliency of BAKELITE Vinyl Elastomeric Plastic helps give a tight, slip-proof hold Perspiration and skin oils can't harm this material That's why it keeps its molded finish so long, why its colors—a wide selection—are so enduring.

When your plans call for a material that combines color, mold fidelity, flexibility, and durability, remember this golf club grip molded from BAKELITE Elastomeric Vinyl Plastics

"Dekoron" tubing extruded by **Samuel Moore & Co.**, Mantua, Ohio

These flexible ¼ in. tubes for pneumatic instrumentation control are extruded from BAKELITE Brand Polyethylene. They saved one chemical plant three-quarters of a million dollars in installation costs by averaging 14½ cents per foot compared with $2.10 for rigid metal tubes.

Here's why: They are easy to install around corners and through hard-to-reach places. Joint fittings need only be finger-tight. The light weight of the tubes permits their ready mounting on tube racks molded from polyethylene. When required, multiple tubes are supplied in harnesses extruded from BAKELITE Vinyl Plastic.

Extruded or molded, BAKELITE Polyethylene offers many outstanding service properties for a growing list of applications. Learn what it can do for your product.

BAKELITE

TRADE-MARK

GREATEST VARIETY, LARGEST RESOURCES FOR PLASTICS KEYED TO YOUR NEEDS

A sure way to get the best material for your product is to consult Bakelite Company. Here you can draw on a single source for the large-volume plastics and resins. A comprehensive fund of information on these materials is always readily available. Technical representatives, backed by Bakelite Company's 40-years of experience, are at your service, together with extensive research and development facilities. Rigid quality control methods are constantly in effect to assure material uniformity. And, for prompt delivery and service, plants and warehouses are strategically located throughout the country. Write Dept. KK-10.

"Tape Rite" dispenser produced by **Cosom Industries,** Minneapolis 16, Minn.

With this new stick-tape dispenser, you just draw the tape along a surface to the desired length. Bend the dispenser back, and the serrated metal spring edge cuts the tape. It's all done with a minimum of fuss, a maximum of neatness.

And the case is a perfect match for the job. Molded from BAKELITE Brand Styrene Plastic SMF-3500 it has fine, clean details, glossy surface, bright colors. Its two halves close with a firm, even fit. Light weight makes it easy to handle.

In comparison with other general-purpose styrenes, SMF-3500 provides easier flow at conventional molding temperatures, resulting in faster molding cycles. SMF-3500 also has outstanding clarity for jobs requiring excellent transparency in crystal or in colors.

Contact block molded by **Furnas Electric Company,** Batavia, Ill., for their series "S" Pressure switches for pumps and compressors.

Molding cycle time cut 20 per cent! That's what the manufacturer reported when BAKELITE Brand Phenolic BMC-5000 Black 25 was adopted for the molded blocks illustrated. And lower specific gravity resulted in a 5 per cent saving in material. In addition, BMC-5000 provided "ease of handling and good mold release qualities."

BMC-5000 Black 25 provides fast curing speed with all molding techniques. It can be molded over a wider time range than other general-purpose phenolics. Its good preheating latitude permits considerable delay in transfer time from preheat to mold closing, without pronounced knit, weld, or flow lines resulting. The excellent blend-to-blend uniformity of this material is the result of rigid quality control during production.

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4 SIZES 3, 5, 8 and 11 gpm

. . . more than double the life of your hydraulic system . . . at no additional cost.

Today's production lines cannot afford avoidable machine breakdowns. DUDCO PF-100 Pumps, rated at 2000 psi for continuous operation, provide the extra margin of operating safety which your customers need so badly. The hydraulic system may not require more than 1000 psi — but the extra stamina provided by a 2000 psi DUDCO Pump cuts downtime AND more than doubles the life and dependability of the hydraulic system.

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TWO VANES ARE BETTER THAN ONE

The hydraulically counter-balanced DUAL-VANES in DUDCO Hydraulic Pumps eliminate wear producing loads normally caused by unbalanced hydraulic forces and vane acceleration. DUAL-VANES also maintain MULTIPLE SEALING BARRIERS to slippage and power loss. DUAL-VANES are a patented and exclusive DUDCO feature.

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INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

News Roundup

(*Continued from* Page 45)

Nice Ball Bearing Co., Philadelphia, Pa., has announced plans for the addition of approximately 20,000 sq ft of space to the present factory. The major part of this additional space will be used for manufacturing purposes, with a portion for the expansion of office facilities.

Meetings

AND EXPOSITIONS

Jan. 9-13—

Society of Automotive Engineers. Annual Meeting to be held at the Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

Jan. 18-20—

Society of Plastics Engineers, Inc. Annual Conference to be held at Hotel Statler, Cleveland, O. Additional information may be obtained from P. J. Underwood, Executive Secretary, 34 East Putnam Ave., Greenwich, Conn.

Jan. 23-26—

Plant Maintenance & Engineering Show to be held at Convention Hall, Philadelphia, Pa. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 23-27—

Institute of the Aeronautical Sciences. Twenty-fourth Annual Meeting to be held at Hotel Sheraton-Astor, New York, N. Y. Additional information may be obtained from society headquarters, 2 East 64th St., New York 21, N. Y.

Jan. 24-27—

American Management Association. General Management Conference to be held at Hotel Fairmont, San Francisco, Calif. Additional information may be obtained from society headquarters, 330

West 42nd St., New York 36, N. Y.

Jan. 30-Feb. 3—

American Institute of Electrical Engineers. Winter General Meeting to be held at Hotel Statler, New York, N. Y. Additional information may be obtained from society headquarters, 33 West 39th St., New York, N. Y.

Feb. 1-2—

Midwest Welding Conference to be held at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. Sponsored jointly by the Foundation and the Chicago section of the American Welding Society. Additional information may be obtained from Harry Schwartzbart, conference chairman, 35 West 33rd St., Chicago 16, Ill.

Feb. 7-9—

The Society of the Plastics Industry, Inc. Eleventh Annual SPI Reinforced Plastics Division Conference to be held at Hotel Chalfonte-Haddon Hall, Atlantic City, N. J. Additional information may be obtained from society headquarters, 67 West 44th St., New York 36, N. Y.

Feb. 8-10—

Western Computer Conference to be held at the Fairmont Hotel, San Francisco, Calif. Sponsored by the American Institute of Electrical Engineers, Institute of Radio Engineers and Association for Computing Machinery. Additional information may be obtained from AIEE headquarters, 33 West 39th St., New York, N. Y.

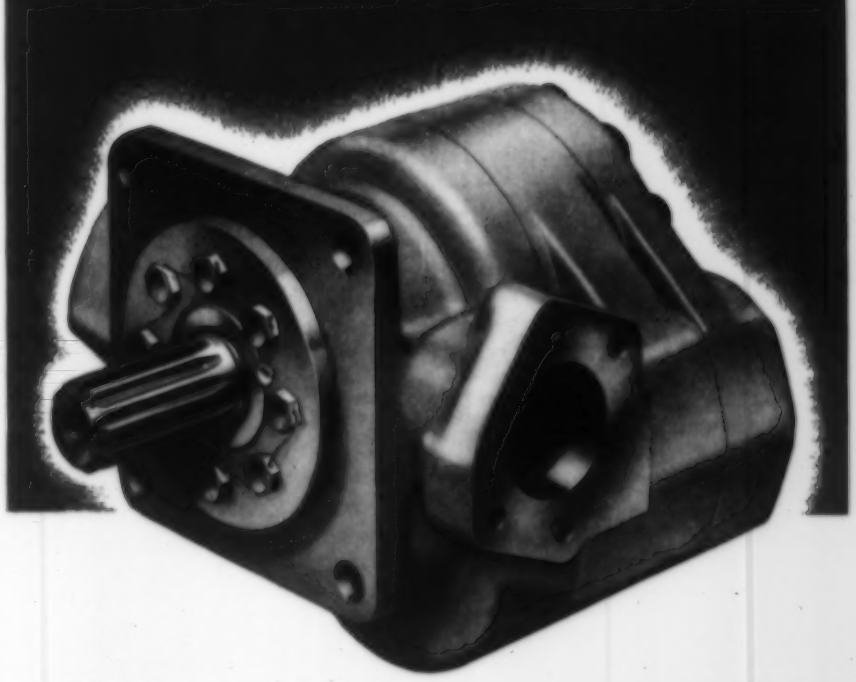
Feb. 27-March 2—

American Society for Testing Materials. National Meeting to be held at Hotel Statler, Buffalo, N. Y. Additional information may be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

March 6-8—

Society of Automotive Engineers. National Passenger Car, Body, and Materials Meeting to be held at Hotel Statler, Detroit, Mich. Additional information may be obtained from society head-

A BIG PUMP for a BIG JOB



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These HYDRECO Pumps are Big News for builders of Big Machines . . . up to 150 Fluid Horsepower output, up to 1500 psi operating pressure! Engineered for installations where space is at a premium and durability essential, these Big 3600 Series Pumps offer equipment designers a proven high volume, high pressure pump. Smooth-operating hydraulic control can now be provided for even bigger designs in mobile and industrial equipment.

3600 SERIES

- 65-90-110 gpm @ 1200 rpm
- Speeds to 2000 rpm
- Pressures to 1500 psi
- Outputs to 150 Fluid Horsepower

The HYDRECO 3600 Series Pumps have been field tested extensively on heavy-duty Mobile Equipment. Operated under the most adverse conditions, even after much abuse, they remained on the job performing efficiently . . . outperforming any other pump previously used in these applications. Downtime for repairs to hydraulic systems was reduced 75-85%. The BIG 3600 Series HYDRECO Pumps really help get the BIG JOBS done easier and more economically.

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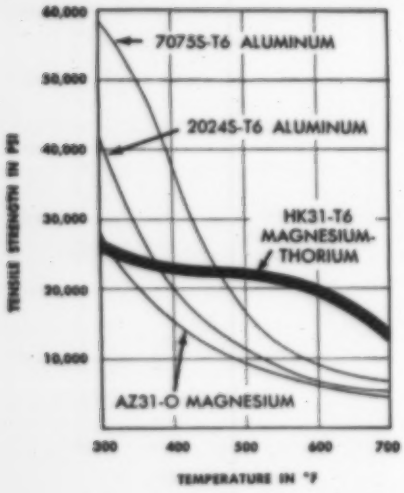
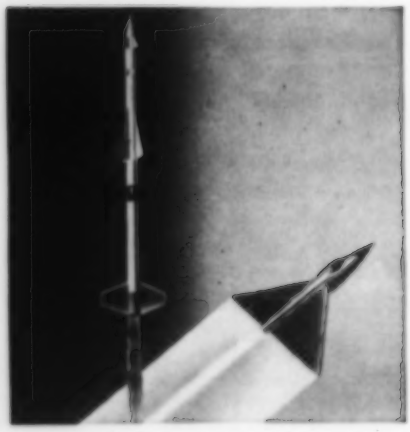


Creep Resistance at 300°-700° F.

In this temperature range, use the thorium-containing alloys of magnesium. They are the only satisfactory metals which combine creep resistance with good strength and light weight.



For designers of high speed jet planes, rockets, and guided missiles, this solves a problem. Formerly it was thought necessary to use heavy materials. They are less satisfactory than these magnesium alloys.

Formerly available in the form of castings only, thorium-containing magnesium alloys now come in rolled sheet. B&P's mill produces this sheet.

B&P engineers will help you redesign in magnesium. B&P offers the magnesium industry's most complete facilities for fabrication and assembly. Your inquiry will bring a descriptive booklet.

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Engineering News Roundup

quarters, 29 West 39th St., New York 18, N. Y.

March 8-9—

The Society of the Plastics Industry, Canada, Inc. Fourteenth Annual SPI Canadian Conference to be held at the Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada. Additional information may be obtained from society headquarters, 67 West 44th St., New York 36, N. Y.

March 12-16—

National Association of Corrosion Engineers. Twelfth Annual Corrosion Conference to be held at Hotel Statler, New York, N. Y. A. B. Campbell, 1061 M & M Bldg., Houston 2, Texas, is executive secretary.

March 14-15—

American Society of Mechanical Engineers. Engineering Management Conference to be held at Hotel Statler, St. Louis, Mo. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

March 14-16—

American Society of Mechanical Engineers. Aviation Division Conference to be held at Hotel Statler, Los Angeles, Calif. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

March 15-16—

Steel Founders' Society of America. Annual Meeting to be held at the Drake Hotel, Chicago, Ill. George K. Dreher, 606 Terminal Tower, Cleveland 13, O., is secretary.

March 18-21—

American Society of Mechanical Engineers. Spring Meeting to be held at the Multnomah Hotel, Portland, Ore. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

March 19-21—

Society of Automotive Engineers. National Production Meeting and Forums to be held at Hotel Statler, Cleveland, O. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

March 19-22—

Institute of Radio Engineers. National Convention to be held at the Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y. Additional information may be obtained from society headquarters, 1 East 79th St., New York, N. Y.

March 19-23—

American Society of Tool Engineers. Industrial Exposition and Annual Convention to be held at the International Amphitheatre, Chicago, Ill. Harry E. Conrad, 10700 Puritan Ave., Detroit 38, Mich., is executive secretary.

March 21-23—

American Power Conference to be held at Hotel Sherman, Chicago, Ill. Sponsored by Illinois Institute of Technology in co-operation with 13 universities and nine national and regional societies. Roland A. Budenholzer, 35 West 33rd St., Chicago 16, Ill., is conference director.

March 26-27—

American Society of Mechanical Engineers. Instruments and regulators Division Conference to be held at Princeton University, Princeton, N. J. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

April 9-11—

American Management Association. Divisional conference on packaging to be held at Convention Hall, Atlantic City, N. J. Accompanying the conference will be the Twenty-fifth National Packaging Exposition. Additional information may be obtained from the American Management Association, 330 West 42nd St., New York 36, N. Y.

May 14-17—

Design Engineering Show to be held at Convention Hall, Philadelphia, Pa. Additional information may be obtained from Clapp & Poliak, 341 Madison Ave., New York 17, N. Y.

MEN OF MACHINES

Worthington Corp., Harrison, N. J., has announced the election of **George F. Habach** to vice president in charge of engineering. He will have full administrative responsibility for the company's engineering activity, including research and development. Mr. Habach completed the Worthington student course after graduation from Stevens Institute of Technology in 1929. He subsequently received his master's degree in mechanical engineering from the Polytechnic Institute of Brooklyn. Mr. Habach has served as chief engineer of the centrifugal pump department and as manager of the Harrison Div. He is a member of the American Society of Mechanical Engineers, the Standards Engineers' Society and the National Society of Professional Engineers.

Harry A. Feldbush, former vice president in charge of engineering, will remain on Worthington's technical staff as consultant on special engineering problems. Associated with the company for over 40 years, he has served as manager of the Cincinnati Works, associate manager of the Buffalo Works, founder and general manager of the company's air conditioning and refrigeration activities, and vice president in charge of the Holyoke Works.

George F. Habach

Formation of a new division devoted exclusively to body engineering has been announced by Pioneer Engineering & Mfg. Co. Inc., Detroit. **C. E. Shutte** is supervising engineer of the new division. He has been a body engineer at Willys Motor Car Co. for the last eight years and previously served for 20 years as body development engineer for Hudson Motor Car Co.

Richard E. Deaux has been appointed director of product development services at Servel Inc., Evansville, Ind. He will be responsible for the welding, machine and model shops; the drafting, blueprint and engineering records sections; the paint laboratory; and the packaging and testing departments. For the last seven years he has been chief engineer of the Coolerator Co., with responsibility for the development and design of refrigerators, freezers and air conditioners. Previously he spent 11 years at Gibson Refrigerator Co. as laboratory supervisor, process engineer, chief process engineer and assistant chief engineer, and eight years at Westinghouse, where he began as an engineer in the test laboratory and advanced to the position of process and tool engineer.

Allen W. Salzman has joined the Waukesha Tool Co., Waukesha, Wis., as chief engineer. He will also head the firm's new thrust bearing division. Mr. Salzman previously was associated with

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STAINLESS STEEL STRIP
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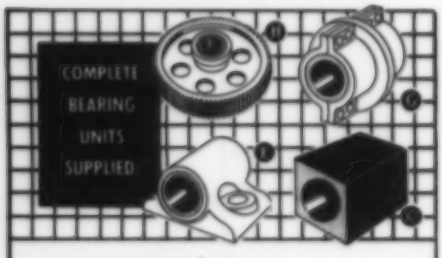

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Men of Machines

Racine Hydraulics and Machinery Inc. as process and development engineer and with Allis-Chalmers Mfg. Co. as design and development engineer in the turbine, generator and marine engineering divisions.

Robert L. Wolff has been elected vice president in charge of engineering of the Centralab Div. of Globe-Union Inc., Milwaukee. An employee of the company since 1937, he has been director of Centralab Products engineering since 1951.

Associated Missile Products Corp., Pomona, Calif., recently announced the appointment of **Earl R. Skaggs**, vice president and former director of product engineering, to the newly created post of assistant general manager and **Joseph Tampico**, vice president and former director of research and development, to director of engineering. The nine-month-old firm is a subsidiary of American Machine & Foundry Co.

Robert J. Levine has been appointed chief engineer of the Edin Co. Inc., Worcester, Mass.

The new Plymouth Div. of Burroughs Corp., Plymouth, Mich., has announced several appointments in its engineering department. **Du Ray Stromback**, formerly associated with the Burroughs research center in Paoli, Pa., has been appointed manager of engineering. He will be responsible for the Sensimatic accounting machine engineering operation at Plymouth. **Byron A. Runde** was named chief product engineer, and **Charles Geisheck** was appointed chief product improvement engineer. Both men have been transferred from the corporation's engineering offices in Detroit.

The election of **G. E. Burks** as a vice president has been announced by Caterpillar Tractor Co., Peoria, Ill. He will continue to give administrative direction to the company's research department and the engineering departments at four plants. Mr. Burks joined

Mr. Design Engineer:

This is your Reliable non-sticking relay

New plunger construction features put this steel-clad Durakool timer-relay in the "fail-safe" group. Mechanical life now 5 to 6 times longer. Any operate-release time combination from 0.15 sec. to 20 sec. — either normally open or normally closed.

GUARANTEED FOR AC-DC APPLICATION and:

★ Extra long life
★ No false contacts
★ Tamper proof (Timing not changeable)
★ Low cost timer

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Durakool

ALL-STEEL MERCURY Timers

G. E. Burks

the Caterpillar engineering staff at San Leandro, Calif., in 1929, transferred to Peoria in 1938 as assistant chief engineer in charge of engine design and was named chief engineer four years later. He was appointed director of engineering in 1953 and was named director of engineering and research the following year. Mr. Burks has been active in the Society of Automotive Engineers, the American Society for Metals, the American Ordnance Association and the American Society of Mechanical Engineers.

Roy H. Kallas has been appointed to the newly created post of general manager of Grieve-Hendry Co. Inc., Chicago. He was formerly mechanical process equipment engineer with the Aircraft Engine Div. of Ford Motor Co.

Joseph Harrington has joined the staff of the Mechanical Div. of Arthur D. Little Inc., Cambridge, Mass. Dr. Harrington will be concerned with design, development and fabrication of automatic machinery for the assembly of intricate equipment, particularly in the field of electronics.

Price Drummond has been appointed director of research and development of the Holo-Krome Screw Corp., West Hartford, Conn. Mr. Drummond was manager of the machinery engineering depart-

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And, this new line furthers the reputation of your equipment thru more rugged performance and dependability.

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Larger, stronger shafts equipped with tapered roller bearings to provide greater capacity and ruggedness.

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ECONOMY
Compare the greater value per horsepower dollar of Winsmith "C" Line Speed Reducers with competitive lines.

Men of Machines

ment of Pratt & Whitney Co. Inc. and previously had served as machine development engineer for National Carbon Co. and chief engineer for Savage Arms Corp.

The appointment of **George F. Hagger** as director of engineering has been announced by Snap-Tite Inc., Union City, Pa. Previous affiliations were director of engineering of Aero Supply Mfg. Co. Inc., project engineer at Chance-Vought Aircraft, and Boeing Airplane Co.

A. D. Schultz has been promoted to the position of chief engineer of the Stamping Div. of Eaton Mfg. Co., Cleveland. He joined the company in 1942 as a draftsman in the Stamping Div. and was made product engineer in 1950.

Commonwealth Engineering Co. of Ohio, Dayton, recently appointed **William N. Carson Jr.** to the post of technical director. Concurrently, **Dietrich K. Hausen** was named director of electrical and electronic laboratories.

Jacob J. Jaeger recently was named vice president and chief engineer of the Machine Tool Div. of Pratt & Whitney Co. Inc., West Hartford, Conn. He joined the company as a research engineer and became assistant manager of machinery engineering in 1948. Mr. Jaeger graduated from Drexel In-

Jacob J. Jaeger

stitute of Technology in 1933 and received his master's degree from Massachusetts Institute of Technology the following year. Until joining Pratt & Whitney he was a research assistant on the staff of MIT. A member of the American Institute of Electrical Engineers, he also has been active in the National Machine Tool Builders' Association.

Theodore von Karman has been named a director of Gruen Precision Laboratories Inc., newly formed subsidiary of the Gruen Watch Co., Cincinnati.

Norden-Ketay Corp., New York, has established a western division in Gardena, Calif. **Herbert Galman** has been named manager of the division's engineering department, and **Harold H. Sarkissian** has been appointed director of the research and development department.

Carl A. Drake has been appointed manager of the manufacturing engineering unit at the Laminated & Insulating Products Dept. of General Electric Co., Coshocton, O. Mr. Drake joined the company in 1940 at the Turbine Dept. in Lynn, Mass., and in 1946 was transferred to Coshocton, where he has held various supervisory positions in engineering and manufacturing.

Control Engineering Co., Detroit, has appointed **William M. Burr** head of the new Aircraft and Missile Section.

Devern A. Chubb has been appointed chief engineer of Abrams Instrument Corp., Lansing, Mich.

Trane Co., La Crosse, Wis., has announced the appointment of **John B. Custer** to the unit heat transfer department.

Roy K. Walthers has been appointed chief engineer of the West Coast division of Trailmobile Inc., Cincinnati. Mr. Walthers will head the engineering department at the Berkeley, Calif., plant. The company also has announced the appointment of **U. Talamini** as head of the product engineering section.

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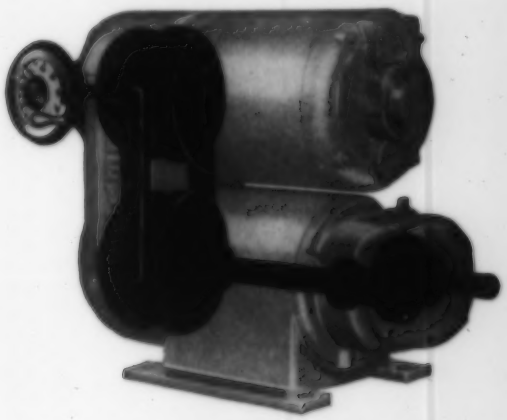

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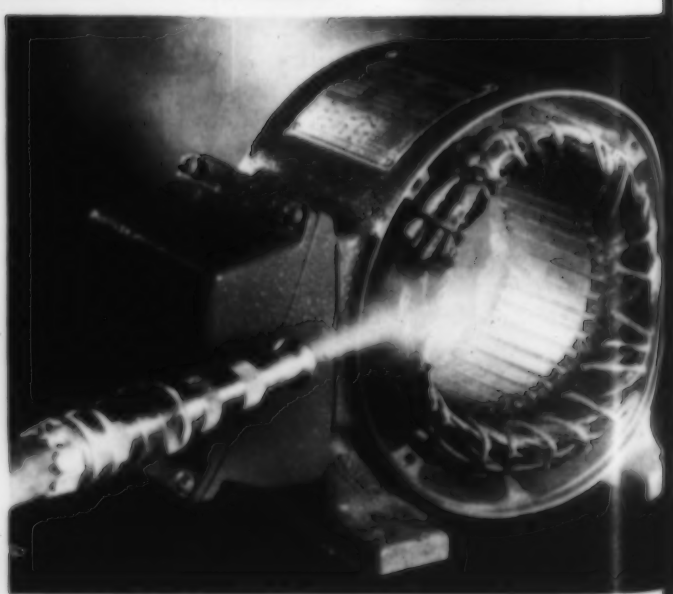

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Engineers and the Management Team

THE current furor over engineers' salaries may be creating a mistaken impression. Man does not live by bread alone, nor do engineers live only for their paychecks. In more or less degree, all engineers feel partially compensated by a sense of achievement and by proper recognition of their status in the scheme of things.

Most management people will say that they expect engineers to think of themselves as part of the management team. But how many managements reciprocate by treating engineers as such?

Many engineers feel neglected—feel that their professional status is not recognized. Specific complaints clearly indicate why they feel more like "hired help" than "part of the management team."

For instance, these gripes are often heard: Unsatisfactory office accommodations; lack of secretarial help; the time clock; no time off for outside professional activities, such as attending conventions; too much detailed supervision; jobs too standardized, leaving no scope for creative thinking; no information on management policies and decisions. There are others, many of which may seem insignificant but which nevertheless loom large in the minds of those affected.

To be sure, many enlightened companies do make conscious efforts to provide a climate in which engineers can grow socially and professionally. Perhaps not enough engineers recognize that the responsibility for their own personal development rests squarely on their own shoulders.

Some companies allow their engineers time off for professional activities and even help defray expenses. But if an engineer fails to avail himself of such opportunities or is unwilling to make any contribution of time and effort to his own professional advancement, can management be blamed for wondering whether this man is the professional he claims to be?

If an engineer shows neither intelligent interest in overall company problems and policies, nor an awareness of costs, has he any right to be regarded as part of the management team?

Actions speak louder than words. To bring engineers into its team, management must accord them the consideration expected toward management people. And if engineers want to achieve recognition, they must work for it.

Colin Carmichael

EDITOR

Engineers and engineering management play a key role in broadening a company's line of products. Successful completion of any program requires a clear understanding of overall company objectives and policies in . . .

DIVERSIFYING

By Philip R. Marvin
American Viscose Corp.
Philadelphia, Pa.
Research Economist

PROFITS depend upon sound product programs. Three major objectives of any business are growth, increased earnings and stability of these earnings. Each depends largely upon the company's product development activities.

The burden and responsibility associated with product development falls upon the engineering group, who occupy a sensitive position with respect to research, production and sales aspects of new product developments.

To accept this burden and responsibility, engineers and engineering management must have a clear picture of the whole company's product-development programming requirements. They should understand and appreciate corporate objectives in diversification.

Diversification . . .

How To Grow

Growth ultimately depends upon new and better products. These new and better products are made possible by:

1. Development of product lines.
2. Design of lower cost products.
3. Diversification of product lines.

Each leads to the goal of new and better products. Both product line development and cost reduction form part of recognized responsibilities of most engineering managers. Such is not the case with diversification. Here, too, engineering must play a vital role.

Successful product programs have generally developed where company management has leaned most heavily upon engineering executives for counsel. By training and experience, engineers are equipped to deal with problems associated with products. Engineers must also have an understanding of broad aspects of product development programs in order to counsel sound management decisions. Engineers must know the whys and wherefores of diversification.

Diversification . . .

Product and Profit Insurance

Profit insurance through diversification is provided in several ways:

1. A company having a single product is in a precarious position. Many factors beyond the control of management's best guidance can upset a single product line. Two or more different products are not apt to be affected in the same way by unforeseen events.
2. Diversification is also inherently a step in growth planning. Through diversification, the corporation provides for growth in new directions.
3. In addition, diversified types of products tend to level peaks and valleys in operating loads.
4. At the same time, while these benefits are derived from diversified lines, engineering and management thinking is also broadened.

Diversification . . .

To Spread Risks

A firm manufacturing one product is seriously affected by any uncertainties that influence the sale of this product, either within the sphere of its direct control or externally. Breakdowns in manufacturing, shifts in demand, and new developments are but a few of the many risks that can

A PRODUCT LINE

WHY DEVELOP NEW PRODUCTS?

Growth is made possible.
Seasonal effects can be leveled.
A hedge against recession is provided.
Impact of business cycles is lessened.
Risks are spread over a wider base.
Work loads can be balanced better.
Management perspective is expanded.
Technical and managerial talents are developed.
Tax advantages accrue.
Excess capital is put to work.
Product line obsolescence is compensated.
Product opportunities are exploited.

affect sales directly or indirectly.

Diversification averages these risks. A shift in demand might affect one product but is not apt to affect two different kinds of products with equal impact. A breakdown in manufacturing might shut off the supply of one product, but under diversified product programming other items would still be available.

Diversification assumes risks but averages their effects. With one product in the line, any risk experienced affects sales. With diversified products in the line, any single risk in all probability will affect only part of the line.

One firm has been totally dependent on lawnmowers for their sales volume for a number of years. Every time an early dry spell occurs, lawnmower sales fall off, inventories remaining high. Low production in the lawnmower industry follows until inventories move. This firm is faced with the risk of a dry spring each year and recognizes that to continue to expose operations to this condition is not wise, since it is unnecessary to depend solely upon a single industry for sales.

A sound course of action is to seek an outlet in a second industry. In this instance, industries should be sought that would not be affected by dry spring weather. The ideal would be an industry that prospers with dry spring weather. Here a rise in sales to one group of customers would always tend to offset a fall in sales to the other group of customers. Business volume would be stabilized.

Engineering managers must shoulder the responsibility for detecting critical points in operations and for providing management with recommended programs offsetting the risks involved.

Diversification . . .

Growth Planning

This aspect of diversification in the framework of a company's activities is so obvious that it deserves mention only to complete the record. Diversification provides new avenues for growth, multiplying the effectiveness of the firm's management and resources.

Managers of technical departments should think in terms of corporate growth. This thinking should be reflected in the form of tangible programming recommendations made to management.

Diversification . . .

To Level Operating Loads

Peaks and valleys in operating curves are costly because every peak represents overstressed facili-

Case Study: AMERICAN MACHINE AND FOUNDRY CO.

A dramatic picture of product development and planned diversification is American Machine & Foundry Co. through the past decade. The growth this company has accomplished through product development suggests ways in which engineers can help their own company to grow. AMF has achieved a growth record of roughly five times gross earnings in a ten-year period.

American Machine & Foundry Co. was founded in 1900 to develop and produce machines for the tobacco industry — cheroot-rolling machines, cigar-bunch wrappers, packaging machinery for smoking tobacco, and a cigarette-making machine were its first products. At the same time the International Cigar Machinery Co., an affiliate formed in 1901, was developing a cigar-making machine.

Executives of this corporation at an early period recognized major problems that confront the machinery industry. Unlike many of their contemporaries, they decided to take steps to solve them. The problems are these:

First, the machinery business has over the years suffered violent swings in activity. Either prosperity or war result in accelerated activity. Periods of relatively level business conditions result in a serious drop-off of volume in the machinery business.

Second, the industry is a manufacturer's manufacturer. In this position it is difficult to boost sales. Machine sales depend upon the customer's ability to boost his output. When business is generally good, it is next to impossible for machinery builders to supply their existing customer's needs, and when business is poor, there is so little volume available that the chances of acquiring new customers are remote.

Third and final, the development of machinery takes a long time and a lot of money. These all contribute to erratic earnings in the industry.

To combat these influences—to level and expand the earnings of the company —was the objective of its executives. Attention was directed at product diversification.

There is no real limit to the extent to which a firm can diversify, but practical considerations establish certain boundaries. American Machine & Foundry's diversification reflects certain practical parameters. All items are fabricated from metal by essentially job shop techniques.

Within these parameters, wide diversification has been achieved. The first departure from the tobacco industry was into the bakery equipment field. In 1924, it entered this field with the introduction of an automatic wrapper for loaves of bread that adjusted the size of the wrapper to the size of the loaf.

Twelve years later, the company entered the apparel industry. The slip-stitching machine offered was an acquired item, improved by AMF engineers.

In 1948, the company stepped into electronics by purchasing the Transducer Corp., now the firm's Electronics Div.

One new venture is into the chemical industry. One of the primary interests of the chemical development group is the reprocessing of tobacco cuttings and waste, including cleaning and the addition of a water soluble gum, so that it can be mixed with regular tobacco in the manufacture of cigarettes.

One of the most spectacular new products is the automatic pinspotter that bowling alley managers and customers have long hoped for.

Results to date speak for themselves. In the ten years period from 1940 to 1950, gross earnings have risen from $5.8 million to $27.5 million, and a single Brooklyn operation has been expanded across the nation.

ties and inefficiencies. Every valley represents equally inefficient undercapacity schedules. Level production loading alone permits engineering economies.

Engineers give a lot of attention to the development of methods of leveling operating loads. Product diversification can make major contributions.

One of the principle causes of cyclical variations in operating loads results from seasonal sales. To offset these seasonal effects a number of approaches can be taken, one of the most common being that of manufacturing for inventory in the slack season. The added costs of carrying the inventory, however, tend to balance the added costs inherent in undercapacity operations and, as a result, reduce the net savings of operating in the slack period.

Product diversification, soundly developed, supplies products with varying seasonal aspects to level operating loads. A rather obvious, but equally profitable, product diversification program developed to level seasonal effects is illustrated in the following case.

A manufacturer of garden tools faced a serious seasonal production and distribution problem. In this industry, dealers place their stock orders in the late fall and early winter, delivery being made during winter months. With delivery into dealer stocks taking place, factory operations dwindle to a standstill in the spring months. To keep the production plant, facilities and personnel employed during the spring and summer, manufacturing for inventory was attempted. Even with a line as little influenced by style changes as a garden tool line, inventories presented many problems.

The solution to leveling operating loads was found in product diversification. The obvious need was for a product that had a seasonal aspect opposite to garden tools, and that could be manufactured in the same factory using machinery and people skilled in making the garden equipment line.

The answer was a winter sporting goods line, representing an expanding market able to absorb output with a season perfectly phased to garden requirements. A long, hard winter would place added demands on winter sports equipment and production facilities but would be followed by a late spring and delayed sales of garden equipment. Here was the ideal combination.

This is the current schedule of operations. Garden tool production begins in September as salesmen get orders from dealers. Production schedules, set up on the basis of estimated sales, are revised as orders start to come in from dealers. Production is scheduled for deliveries to commence as finished goods come off the line, allowing a saving in inventories or receivables. By the end of February, production of rakes, hoes, forks, and other garden tools is stopped, and production facilities are switched to winter sports equipment: snowshoes, skis, sleds, toboggans, and other items. These require similar know-how and facilities for both woodworking and metalworking.

Winter sports equipment is in production until

A MANAGEMENT VIEW OF DIVERSIFICATION

These questions will be asked . . .

BACKGROUND OF EXECUTIVE EXPERIENCE
What talent going beyond the existing product line is available?

FINANCIAL POSITION
How large in amount are excess funds over current operating requirements?

FISCAL POLICIES
Are they flexible?

STOCKHOLDER REACTION
Is it favorable to new ventures?

CORPORATE CHARTER
How wide is its scope?

CORPORATE STRUCTURE
Can it be adapted to new undertakings?

DIRECTORSHIP ANALYSIS
How would the directors feel about the idea?

PRODUCT SENSITIVITY
Would the present line be sensitive to a new line?

MARKET STRUCTURE
What is its character?

DISTRIBUTION CHANNELS
How would they fit a new undertaking?

SALES VITALITY
How healthy does it look?

PRODUCTION FACILITIES
How adaptable are they?

PRODUCTION EFFICIENCY
Is this factor relatively competitive?

DEVELOPMENT REQUIREMENTS
Is the engineering group well supplied with talent?

MANAGEMENT OBJECTIVES
Do these conflict with deversification objectives?

PROGRAMS
How well developed are the programming methods?

POLICIES
How flexible are they?

August, when production is switched back to garden tools. Throughout the year production schedules are based on orders, and goods flow directly to customers.

Representing an ideal combination of product lines, the two lines are two different seasonal types, and both lines are hard goods purchased by all income groups. The lines have a high degree of stability.

Engineering managers taking an active interest in leveling out operating loads should examine product diversification possibilities closely.

Diversification . . .

A Product Problem

Diversification is a problem of broadening the product base by expanding product lines. There are several ways of expanding product lines to broaden this base.

1. A product can be developed.
2. A fully designed product can be purchased.
3. A going business with a desirable product can be purchased, and the product integrated into the line.

Each of these courses of action has been successfully exploited. Each presents technical problems requiring engineering know-how for effective development.

Diversification . . .

An Engineering Management Problem

The familiar advice "Don't put your eggs all in one basket!" applies to business as well as personal affairs. The successful outcome of diversification programs undertaken by a number of corporations has spurred on others.

One engineering executive has remarked that he doesn't expect to eliminate headaches through diversification, but he expects to spread them out and at the same time to increase profits.

Increased profits is the common goal stimulating diversification.

Another corporation president has stated, "What we are looking for is a new product that will give us a chance to get in on the ground floor of an expanding market. The product ought to be one we can sell in a pretty well-established market at a fair return on our investment. We don't want to pioneer, we want to work with a pretty well defined item that is recognized by the market and has established its own niche."

The goal this executive sets sounds good but is unrealistic. A new product in an expanding market cannot be a well-recognized item in an established market. Men who are looking for new products must make some guesses about market potentials, profits, and other factors. Courage to make decisions based on guesses is called for.

The only attitude conducive to the development

Case Study: HERSCHEDE HALL CLOCK CO.

An example of product diversification recognizing the technical similarity of product lines was carried into profitable production by Herschede Hall Clock Co.

For many years, this firm has manufactured for national distribution a high-grade line of clocks. These clocks reflected sound engineering and thorough knowledge of the clockmaker's art. In addition to engineering soundness, these clocks demonstrated manufacturing know-how.

In searching for a new product line to supplement clock sales, technical considerations coupled with recognized sales opportunities led to the selection of parking meters as a venture.

Functionally, both clocks and parking meters are timing devices. A firm that can be commercially competitive in one field with a quality product can be commercially competitive in the other field with a quality product.

The fact must not be overlooked, however, that commercial competitiveness in both cases depends upon technical ability and capacity, and full utilization of both of these.

Had this firm's search for a new product failed to recognize fully the company's technical background and facilities it would have been impossible to evaluate new product proposals against available talent and facilities. Few diversification programs, if any, have been more closely tuned to utilization of the firm's existing resources.

of new products is one accepting uncertainties and willing to gamble. If this attitude is adopted, ideas have a reasonable chance of developing into profitable products.

Diversification . . .

Engineering Economics

A shakedown is part of the job. Ideas must be screened with broad manufacturing, marketing, product, management, profit, patent and legal aspects in view. This calls for a rough-and-ready process of selecting ideas that appear to be the best of the lot. These must again go through a shakedown that is more severe because, on the basis of this analysis, a product idea is to be selected in which a considerable amount of money may be invested during its development phase.

No known way exists of circumventing guesswork here, but organized, informed guesswork can be better than a stab in the dark to pick a product.

The only defense that can be offered to those who feel that this is a flimsy basis for executive decisions is to say that if you can be right in your decisions more often than your competitors, you can't lose. Organized guesswork is the only known way to achieve this distinction.

Diversification . . .

Appraising Product Proposals

Effective technical appraisal of product proposals calls for a variety of engineering skills. All important aspects of product proposals must be analyzed and evaluated.

Engineers must conduct both literature and technical research. Each is necessary to increase the effectiveness of the other.

Experimental, creative design and model development skills are necessary in exploring product proposals fully. These should be completed before passing upon the soundness of individual proposals.

Testing will be called for. Production engineering phases of the program, too, should be carefully explored and appraised.

Technical requirements of the selling program are also an extremely important phase of the engineering appraisal. A product is only successful when a customer is satisfied.

Diversification . . .

An Opportunity and Responsibility

Successful programs must combine two important elements. These questions must be answered affirmatively:

1. Are we qualified to tackle this job? A well-organized and oriented attack is vital.
2. Does the product proposed pass our qualification tests? A critical outlook reflecting breadth and maturity is required in examining product proposals.

Just plain effort won't be enough to do the job. Knowledge and experience must be combined. The first ingredient can be acquired, and the second ingredient can be developed.

Engineering talent is the key to success or failure in diversification programming. In these competitive days, leaders in successful diversification programming have placed engineers in top positions to steer the course to greater profits. Recognizing fundamentals of the problems involved, technically trained talent can achieve startling results in corporate growth.

26 56

Announcing . . .

Publication Every Other Thursday in 1956

IN 1956, MACHINE DESIGN will increase frequency of publication to every other week. This new policy—a major advance in MACHINE DESIGN's 26-year history — has two purposes:

1. To provide a slimmer, easier-to-read magazine, and
2. To expand the total number of editorial pages over the year.

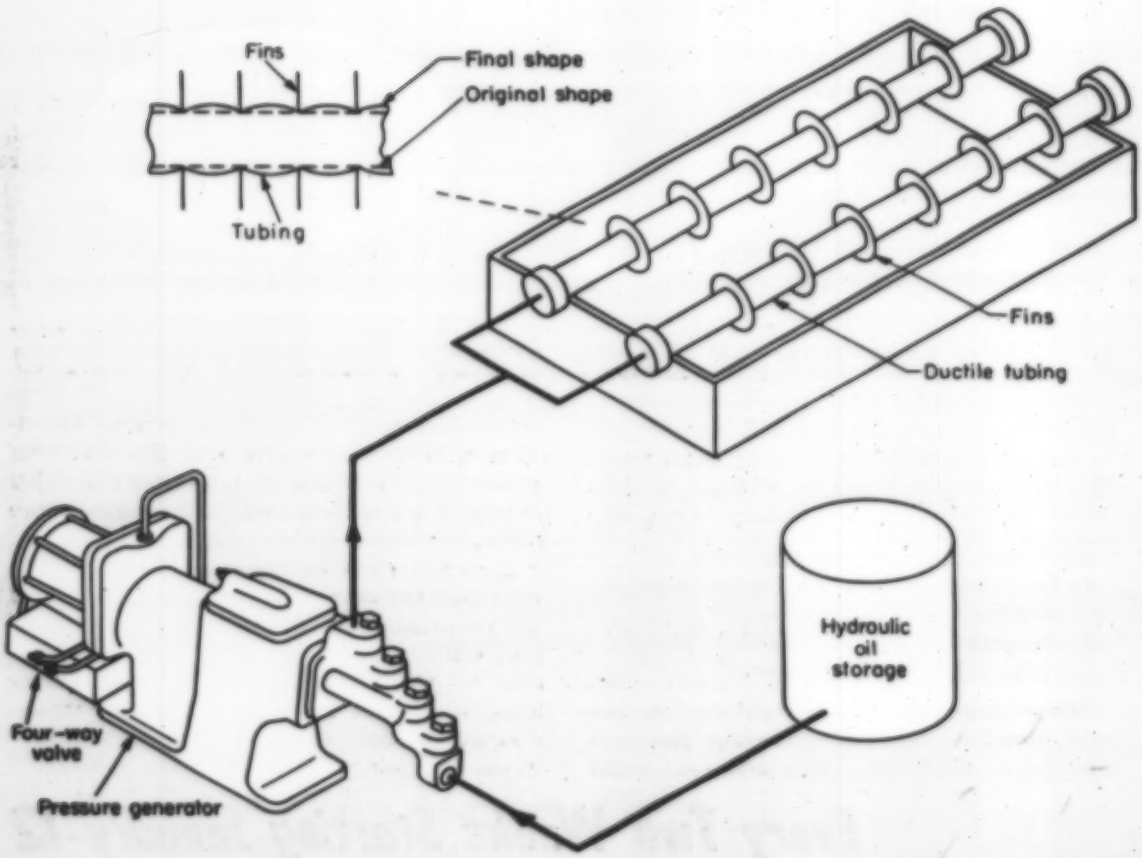
This change to biweekly publication has been prompted by the increasing size and complexity of design engineering—a trend which has been reflected by a large expansion in MACHINE DESIGN over the past four years. We believe that most readers will enjoy sitting down with a smaller magazine more often.

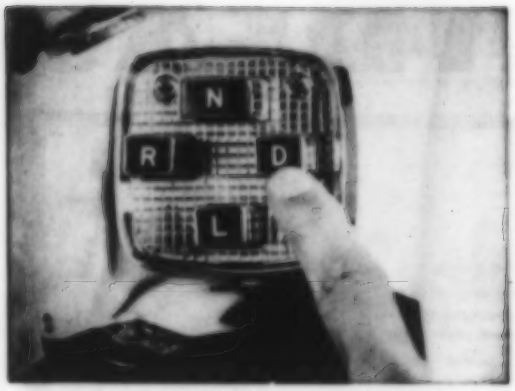
Each issue will be trimmed to a little more than half the current size. But with 26 issues per year instead of 12, the total editorial content will be greater. MACHINE DESIGN will be able to offer even more engineering assistance, with some room for additional expansion as the field of design engineering continues to grow.

Every Two Weeks Starting January 12

scanning the field for Ideas

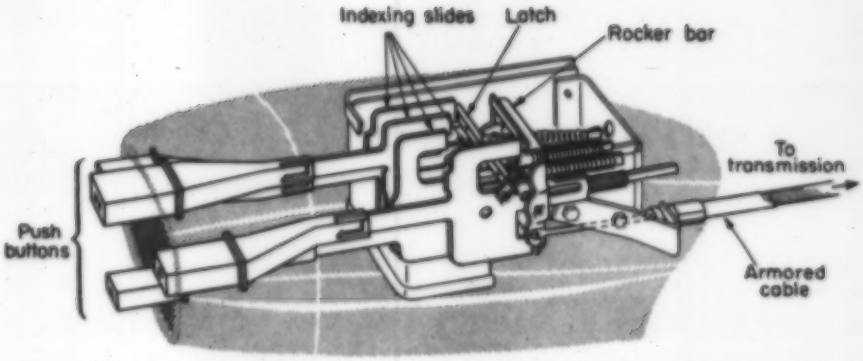
EXPANSION LOCKING by hydraulic pressure offers a new approach to fabrication of metal-parts assemblies. Utilizing a high-pressure pumping system developed by the Milton Roy Co., this fabrication technique is now employed to simplify the manufacture of fin-tube heat exchangers. To fabricate the fin-tube unit, stamped metal rings are threaded on a piece of ductile (copper or aluminum) tubing. The tube is closed at one end with a cap and is connected to the high-pressure pump at the other. After the rings have been positioned, the pump is allowed to generate a pressure great enough to expand and slightly deform the tube, locking the rings in place.



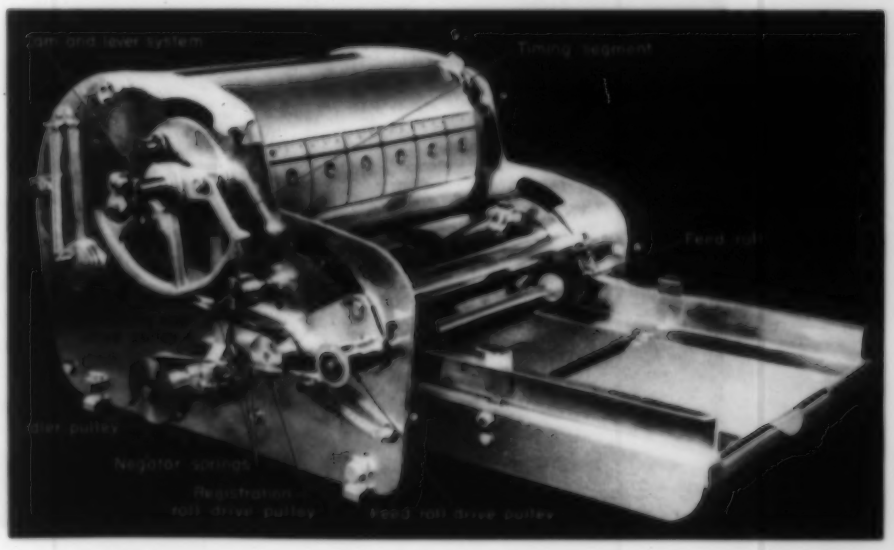


PUSH-BUTTON CONTROL of automatic transmissions permits use of a simple flexible-cable actuating linkage. All mechanical in design and operation, the push-button drive selector is standard in 1956 Chrysler Corp. cars equipped with PowerFlite.

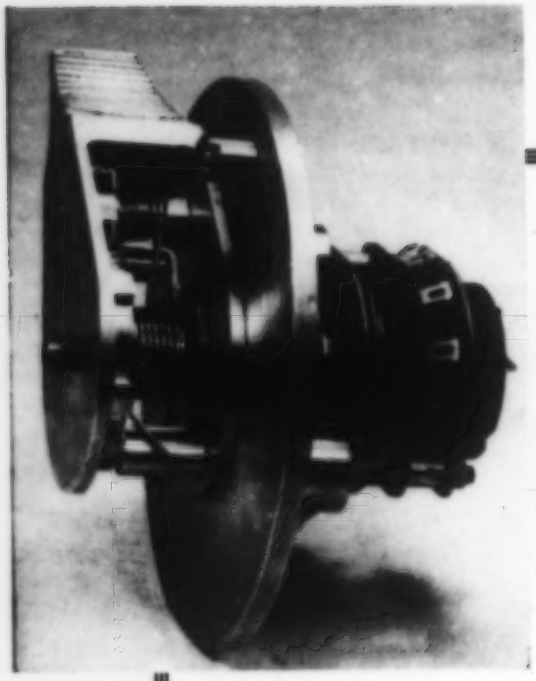
When depressed, the selector buttons push indexing slides against a rocker bar which moves an armored actuating cable different predetermined distance. This cable linkage is connected to the manual shift valve in the transmission. Since the projections on the indexing slides are all different in length, pushing in any one button moves the cable to a specific control position.

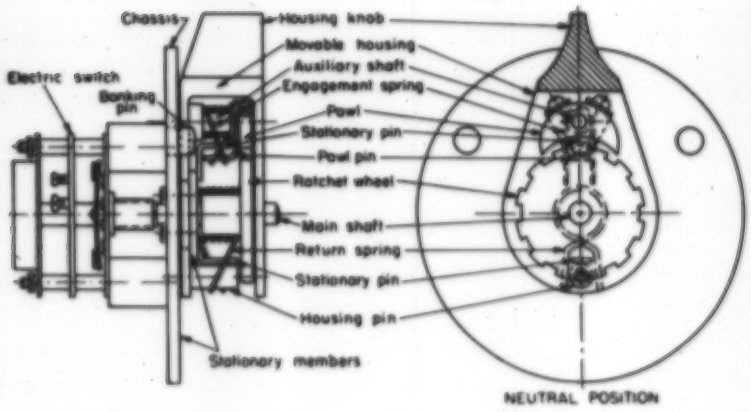


ACCURATE CONTROL of mechanically transmitted oscillatory motion is obtained with flat metal "belts". A manually operated duplicating machine produced by Standard Duplicating Machines Corp. uses Neg'ator springs to link and synchronize the action of paper-handling rollers to the timing drive assembly. Ribbon-like stainless steel springs coil tightly around the roller drive pulleys. The free ends of two of these springs are fastened directly to the timing segment which is cam-and-lever driven. The third spring is attached to an idler pulley. The constant tendency of these springs, when extended, to return to their original coiled condition causes them to rewind smoothly on the drive pulleys as the pulleys are returned under spring tension to the cycle starting position.

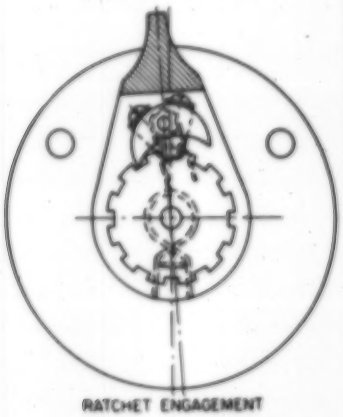


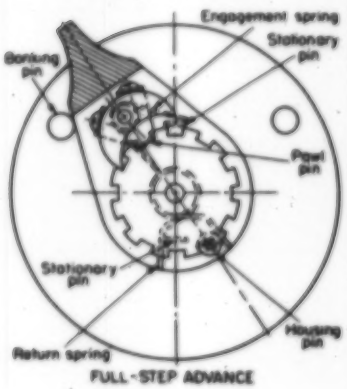
IDEAS





NEUTRAL POSITION


RATCHET ENGAGEMENT



FULL-STEP ADVANCE

CONTROLLED SEQUENCING of manual switching operations is obtained with a bi-directional pawl-and-ratchet mechanism. Developed for use with rotary multistep switches, the mechanism designed by B. J. Popper under the auspices of the Ministry of Defense of Israel prevents the switch from advancing more than one step at a time in either direction of rotation without returning to a neutral position.

The mechanism assembly is composed of three basic operating elements: a toothed ratchet wheel, a housing and a crescent-shaped pawl segment. The ratchet wheel is fixed to the main shaft which, when turned, advances the rotary switch. Rotation of the housing, which is free to turn on the main shaft, in either direction from neutral automatically engages the pawl with the ratchet wheel, locking the housing to the main shaft and advancing the switch. Banking pins limit rotation to one step at a time. Before the switch can be turned to the next step, the housing must return to the neutral position.

Automatic lock-up of the housing to the ratchet wheel and automatic return to a neutral position is provided by spring action. When the housing is rotated from neutral, pins on the pawl and chassis act to spread the legs of an engagement spring. This action applies pressure to one side of the pawl causing it to tilt into one of the notches on the ratchet wheel. A return spring functions in a similar manner to automatically return the housing to the neutral position when released by the operator.

Photocopy Techniques for Engineering Records

Case histories showing work simplification in processing and duplicating drawings and records

By Spencer R. Griffith*
Engineering Services Supervisor
Hamilton Watch Co.
Lancaster, Pa.

MAINTENANCE of engineering records is essential, but such activity can become burdensome and time-consuming. It is an ideal area to be watched for short cuts and the possible application of new techniques. The traditional criteria can be applied: Will a better job result, with expenditure of less time and money?

Three examples are presented in this article, showing how photocopy techniques have been adapted to the simplification of drafting and record problems at the Hamilton Watch Co. Perhaps they will suggest ideas of usefulness to other engineering departments.

The problems arose particularly in connection with Hamilton's military production over the last five years. Orders for parts and assemblies originated with government departments such as the Navy Bureau of Ordnance and the Army Ordnance Corps, and with other prime contractors. Working drawings originated at many sources and were supplied to Hamilton in the form of prints of many different kinds and in a great variety of sizes. Frequently these prints were difficult to read and impossible to duplicate legibly. These variables had to be corrected in order to facilitate the execution of the several contracts.

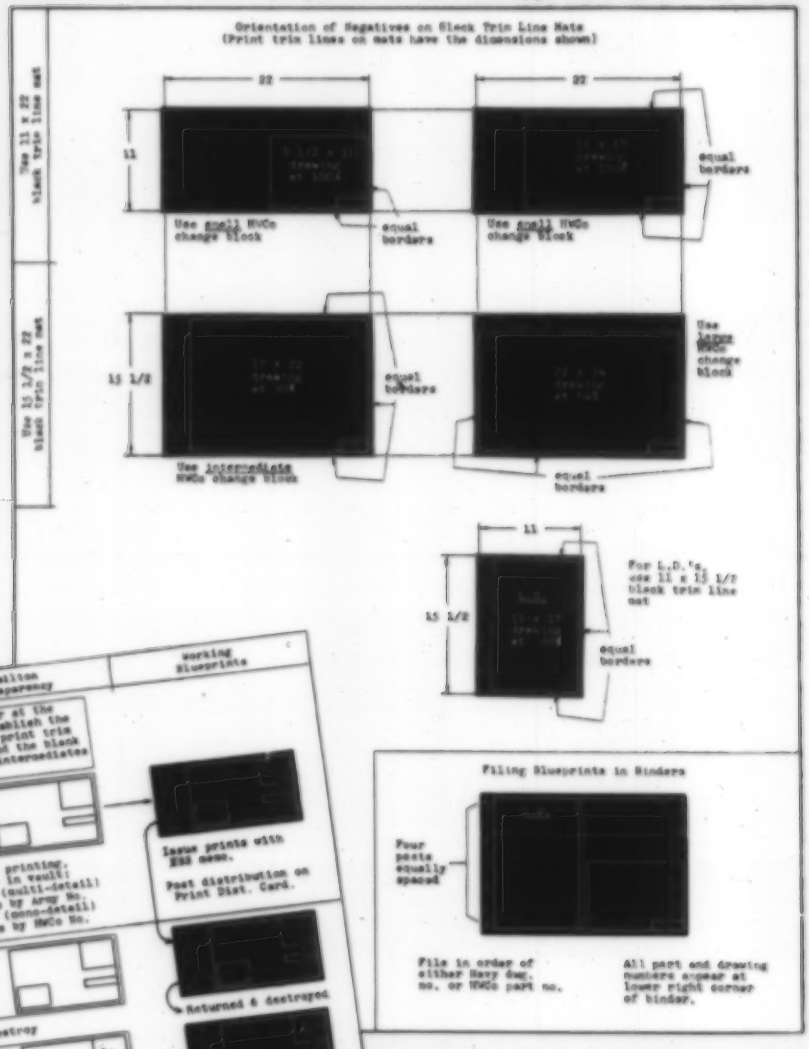
*Now assistant editor, MACHINE DESIGN

For one group of drawings, redrafting was tried at first. But it soon proved both expensive and time-consuming. Photocopying was then tried, and it proved practical in providing clear, legible prints in standard sizes at a minimum cost within a reasonable time.

The methods worked out for using photocopying have completely replaced redrafting, with a few rare exceptions. They have now been in use at Hamilton for periods from one to four years. Some of them are described in this article.

Production of standard-size working blueprints from Navy Bureau of Ordnance drawings was one of the problems. Navy Ordnance drawings are prepared in four sizes: 8½ in. by 11 in., 11 by 17, 17 by 22, and 22 by 34. The size 11 by 17 is also used, with the longer dimension vertical, for Lists of Drawings. Prints of Navy drawings supplied to Hamilton as a contractor are generally in the form of Van Dyke type positives the same size as the originals. Often, however, other types of prints are supplied, and some of these are reductions.

Duplication of these assorted prints by the most expedient process, depending on the kind of print received, resulted in a wide variety of kinds and


Orientation of Negatives on Block Trim Line Mats
(Print trim lines on mats have the dimensions shown)
Use 11 x 22 block trim line mat
Use 15 1/2 x 22 block trim line mat
22
11
15 1/2
Use small HWCo change block
Use intermediate HWCo change block
Use larger HWCo change block
equal borders
For L.D.'s, use 11 x 15 1/2 block trim line mat
Filing Blueprints in Binders
Four points equally spaced
File in order of either Navy dwg. no. or HWCo part no.
All part and drawing numbers appear at lower right corner of binder.

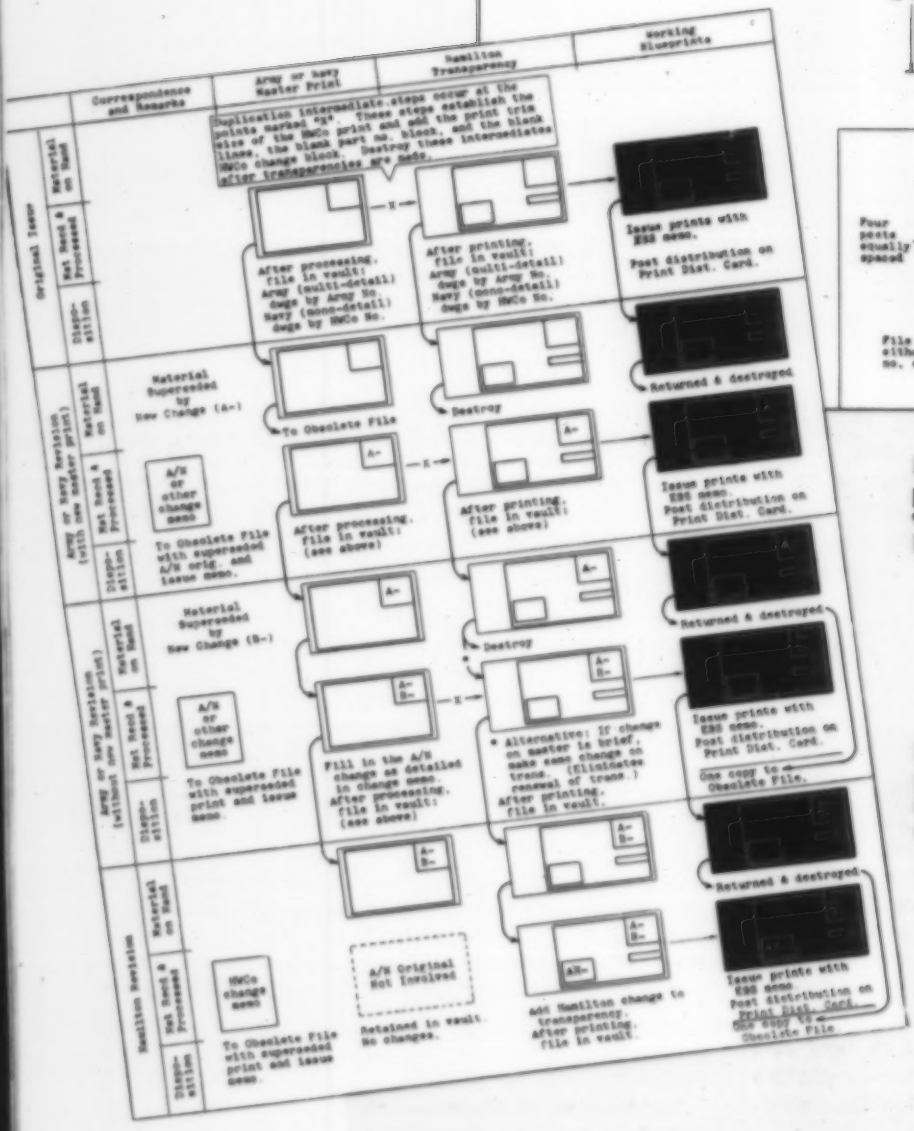

Correspondence and Remarks
Army or Navy Master Print
Hamilton Transparency
Working Blueprints
Original Issue
Army or Navy Revision (with new master print)
Army or Navy Revision (without new master print)
Hamilton Revision
Material on Hand
Not Rent & Processed
Disposition
Duplication intermediate steps occur at the points marked (x). These steps establish the sizes of the HWCo print and add the print trim lines, the blank part no. block, and the blank HWCo change block. Destroy these intermediates after transparencies are made.
After processing, file in vault: Army (multi-detail) dwgs by Army No. Navy (mono-detail) dwgs by HWCo No.
After printing, file in vault: Army (multi-detail) dwgs by Army No. dwgs by HWCo No. Navy (mono-detail) dwgs by HWCo No.
Issue prints with ESS memo. Post distribution on Print Dist. Card.
Material Superseded by New Change (A-)
To Obsolete File
Destroy
Returned & destroyed
A/N or other change memo
To Obsolete File with superseded A/N orig. and issue memo.
After processing, file in vault: (see above)
After printing, file in vault: (see above)
Material Superseded by New Change (B-)
To Obsolete File with superseded print and issue memo.
Fill in the A/N change as detailed in change memo. After processing, file in vault: (see above)
* Alternative: If change on master is brief, make memo change on trans. (Eliminates renewal of trans.)
After printing, file in vault.
One copy to Obsolete File.
HWCo change memo
A/N Original Not Involved
Retained in vault No changes.
Add Hamilton change to transparency. After printing, file in vault.

Fig. 1 — Upper — Details of production of standard-size working blue prints from Navy Bureau of Ordnance drawings

Fig. 2 — Left — Procedures for processing Army and Navy manufacturing drawings, both originals and subsequent changes

sizes of prints circulating in the Hamilton factory. The condition became intolerable. As a corrective and control measure, a system of size standards was initiated which depends largely on photocopy techniques, *Fig.* 1. The principal features and characteristics of the size-standards system are:

1. Regardless of the kinds and sizes of prints received, they are processed photographically into negatives of identical size or at specified reductions of the original tracings, the maximum size being 15½ in. by 22 in. High-contrast paper is used (either Haloid F-4 or Photostat A). Prior to photocopying, an appropriately sized Hamilton part number block is affixed over the proprietary block in the Navy drawing. Elsewhere on the Navy drawing, where space permits, a Hamilton Watch Co. change block of specified size is located.

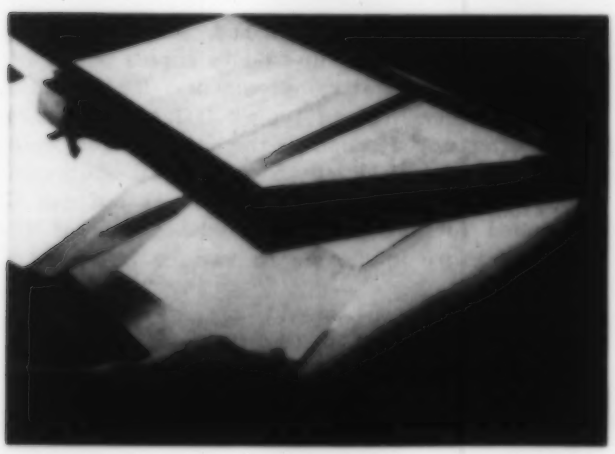
2. Negatives are trimmed just beyond inside drawing borders, and then are oriented on black trim line mats.

3. Full-size positive transparencies are made from the negatives on the mats using transparent negative paper (Haloid Transaloid). The trimmed transparencies, which have the trim lines of the standard sizes indicated, are the company's duplication masters. To them are added the five-digit Hamilton part numbers used in Hamilton's machine-accounting system.

4. Working blueprints for manufacturing and engineering use are then made from these transparencies.

5. Blueprints are filed in a binder with all part and drawing numbers appearing at the lower right-hand corner of the binder, thereby facilitating the search for prints. Prints can be filed in the order of either Navy or Hamilton numbers depending on the convenience of the user. The maximum size of 15½ in. by 22 in. assures that a folder of prints will fit within the area of a commercial desk blotter—often the limit of space available at the point of use. This size also assures that prints will be small enough to be handled easily but large enough to be read easily and to permit changes directly on the new positive transparencies. In every case, the blueprints made from the new transparencies are of better quality than those made directly from Van Dyke type prints supplied.

Fig. 3—Cards carrying part names, part numbers and corresponding Hamilton numbers arranged two columns per page on table of photocopying machine



Records processing of Army and Navy manufacturing drawings became a problem as the number of parts and drawings increased. In the preceding section, the description of the preparation and use of transparencies as Hamilton duplication masters pertains essentially to the original issue of the government drawings. As a result of accumulated manufacturing and service-use experience, changes in parts are continually being made after parts enter production.

The changes are published in two ways, depending on their extent and importance. The service originating the change may provide new part drawings which include the changes and also a change description, or it may simply describe the change without altering the drawings at the time.

If new drawings are provided, they are photocopied by the same procedures used for an original issue. The former government print and Hamilton transparency are superseded.

When new drawings are not provided, the change being detailed simply in a notice or memorandum, new working prints are made in a different procedure. The change is added to the former government print by the most expedient method depending on the kind of print. If the change is extensive, a new transparency is made from the changed print. If the change is not extensive, it is repeated on the former transparency. In either case, new working blueprints are made from the transparencies and distributed.

Another situation that effects the records arises when there is an engineering change originated by Hamilton and which is effective only at Hamilton. In this case, only the transparency is modified. The origin and status of the revision are indicated on the Hamilton master transparencies in the change blocks which had been added photographically. Such changes, not being recognized by the contracting military service, are not added to the originals received from the services. Blueprints from such revised transparencies are made and distributed as in the case of any other revision. *Fig.* 2 summarizes these procedures.

Besides the features given in the first part of this article, the transparencies have these other advantages in the case of changes:

1. They enable engineering and manufacturing departments to have all current changes on working prints regardless of the form in which they were issued by the contracting service.

2. Being positives, the transparencies can be modified in exactly the same way as original tracings. Often this means that transparencies need only be revised not renewed.

3. Local changes can be distinguished from official changes and treated separately. Production is not interrupted and the official documents are undisturbed in case either kind of change becomes an issue in contract negotiations.

Part Name	Customer Part No.	HWCo Part	Customer
Spacer Washer	1101326	38762	Navy
Partition	1103279	38795	Navy
Pawl, Idler	1103280	38796	Navy
Separator Pad	1103300	38801	Navy
Rocker	11035-1	38759	Eastman
Set Back Pin	1103706	38604	Navy
Slider	1103716	38615	Navy
Slider Retainer	1103717	38616	Navy
Hub	1104-5	37501	Landis
Hub Sleeve	1104-7	37502	Landis
Washer (Alternative)	1104803	38618	Navy
Pinion No. 1	1104817	38752	Navy
Pin Setting	1116A	38802	Armstrong

Part Name	Customer Part No.	HWCo Part	Customer
Diaphragm, Safety	73-9-156	37609	Army
Sleeve, Safety	73-9-201	37611	Army
Searing Compound	73-9-210	37615	Army
Lead Wire	73-9-352	37621	Army
Wire, Lead (.010)	73-9-462	37651	Army
Clamp, Collar	742389-1	38622	Delco
M301 Assembly	74-2-43A	37989	Army
Carrier, Ammunition	76-1-1149	38765	Army
Box, Packing	7-BX-590	39906	Elgin
Partition	80-A-140	39908	Waltham
Rotor Pin	81E-3562	34761	Armstrong
Lead Pin	1116A	38802	Armstrong

Fig. 4—Specimen pages of part number cross-reference list run off by Multilith from a master prepared from a negative photocopy

Cross reference tabulation of customer and Hamilton part numbers became an obvious necessity. As mentioned earlier, Hamilton part numbers are assigned to contracted parts and products. These five-digit numbers substitute a single system of identification for many systems originating with as many customers. The five-digit numbers are essential to the successful operation of the machine-accounting system which is used for all contract and regular product activity.

Both customer and Hamilton part numbers appear on the drawings for contracted parts issued to manufacturing and engineering organizations. But many other departments such as purchasing or accounting need to know only the numbers. Often, also, the departments which have prints find useful a cross-reference list of customer numbers and their Hamilton counterparts.

To satisfy these needs, a tabulation was prepared and brought up to date periodically. As the contract program grew, the tabulation lengthened. It soon became evident that the conventional methods of typing and duplicating the list were expensive, time-consuming, and even inaccurate. Again, photocopy methods were employed. This tabulated record is maintained and duplicated as follows:

1. On cards 4¾ in. by 7 in. cut from commercial stock, the part name, customer number, Hamilton number, and customer name are listed. Initially, five items per card are listed in the order of the customers' part numbers. Customers' numbers are listed in numerical order, then alphabetical. Punctuation, such as dashes, periods and bars are copied but disregarded in determining sequence. Numbers are sorted beginning with the left-hand digit and proceeding to the right without regard to the length of numbers; thus, 100000 precedes 111.

2. The five-item cards are filed in a simple box and constitute a complete up-to-date list of customer parts and Hamilton numbers.

3. As new customer part numbers occur in the system, they are added to the proper cards. At that time, individual cards are retyped, if necessary, to maintain proper numerical order. Additional numbers are added until a maximum of eight items per card is reached. Then the items are divided on two cards, four items per card. From four items, cards are allowed to build up again to eight. Item deletions are the reverse of this process.

4. The complete list of numbers is republished periodically and copies sent to all who use the information. In republishing, the cards are first laid on the table of the photocopying machine, in the proper numerical order. The cards overlap and are staggered to provide "eye-rest" breaks between the number groups. The fact that not all groups have the same number of items is thought to be inconsequential considering the advantages of the addition and deletion process described in Step 3. Column heading cards are added at the tops of all columns of cards. One exposure consists of two columns of cards with eleven cards and one heading per column, *Fig.* 3. A negative of this arrangement is made at 66 per cent reduction on transparent negative paper.

5. The transparent negative is pieced and retouched to remove the shadows at card edges. From the negative, a sensitized paper master for a Multilith machine is prepared and copies from the processed paper master are then run off, *Fig.* 4. Sufficient pages are made so that all the number cards are copied. The same results can be obtained, perhaps in less time, by the use of electrostatic (Xerox) equipment which substitutes a charged plate for the photographic negative.

By the procedures described, photocopy techniques have provided up-to-date copies of an important administrative document. The process minimizes retyping and typing fatigue which is a cause of errors. It removes the necessity for proofreading. At the Hamilton Watch Co. it accommodates nearly a thousand line items but can be expanded for many more. Modifications of the same idea are applicable to various other kinds of records.

ACKNOWLEDGMENT

This article is based in large part upon a prize-winning entry in the "Photocopy-in-Industry" contest recently conducted by Peerless Photo Products Inc.

High-Speed Web Cutting

Speed and accuracy of cutting a continuously moving web into sheets depend on a number of design factors. Two important considerations are the type of shearing-cutter design and cutter speed control. With roll paper or similar material, choice of shearing cutters is rather broad:

1. **Helical flycutters**
2. **Hyperbolic flycutters**
3. **Dual rotating shearing knives**
4. **Dual oscillating shearing knives**

This article details where and how to use each of these four shearing methods for high-speed web cutting. Advantages, limitations and speed control of each are considered.

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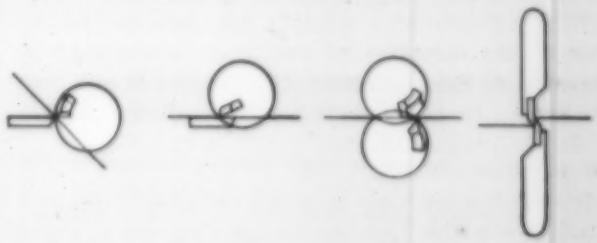
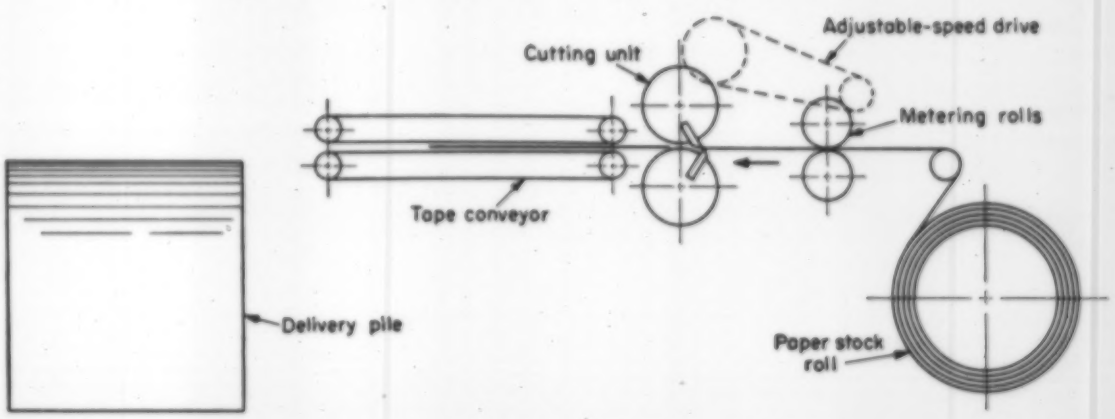


SHEETING is an operation by which a flexible web of paper or similar material supplied in the form of a roll is cut transversely to sheets of a given length. Usually accuracy of this operation is of considerable importance. The sheets should be cut exactly to the length desired, and the cut edge should be straight and perpendicular to the longitudinal edge of the sheet. Most sheeters must be designed so that the length of the cut-off can be adjusted by small increments. In thicker stock, like carton stock, bevel angle of the cut edge should be close to 90 degrees.

On present machines for large-scale operation, sheeting is performed almost exclusively while the web is moving continuously. General arrangement of a high-speed sheeter is shown in *Fig.* 1. Sheet length is controlled by the ratio of cutter speed to the speed of the metering rolls. This speed ratio can be varied by means of change gears or by an adjustable-speed drive. The sheeter is usually

Fig. 1—General arrangement of a typical high-speed sheeter



designed for a certain maximum sheet length.

The cutter severs the sheet by the shearing action of two knives. One blade moves past the other, and one knife edge is slightly inclined so that the cutting point gradually advances across the web. The angle of inclination usually is very small so that there is no danger of lateral sliding of the web. A small angle of inclination results in a short cutting period which is of advantage in certain sheeter designs.

In the design of a sheeter, this gradual knife action as well as cutter speeds and web speeds associated with a given range of sheet lengths must be taken into consideration.

Two types of shearing cutters can be distinguished. In one type both knives perform a motion in the direction of the web flow during the cutting operation. In the other type—flycutters—only one knife performs such a motion while a second knife remains stationary. The moving knife performs a continuous rotation in this latter type.

With a flycutter, a straight cut made perpendicular to the direction of web flow is obtained if the edge of the stationary (bed) knife is not perpendicular to the direction of web flow for this reason: during the time between beginning and end of the cutting action, the point on the web where cutting starts advances with respect to the point on bed knife where cutting starts. As a result, the bed knife must be positioned so that the point on the bed knife where cutting terminates is advanced, in the direction of web flow, with respect to the point on the bed knife where cutting starts. The distance this point advances is equal to the travel of the web during the cutting period. Thus, the bed knife must be tilted with respect to the direction of the cut edge.

To have the knife edges contact one another, the edge of the bed knife must lie on a surface generated by the rotation of the rotary knife edge about its axis. Shape of the knife edges and speed of the rotary knife must be co-ordinated so that a straight cut results. Component of knife speed in the direction of web flow must be equal to or larger than the web speed so that the rotary knife does not impede the advance of the web or cause it to wrinkle or tear.

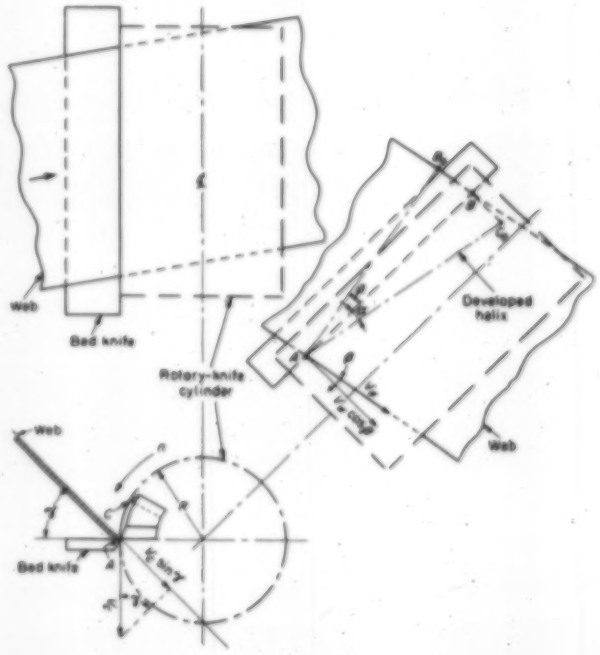
In flycutters, where the edge of the bed knife is straight, the associated rotary knife can be designed to meet other arbitrarily chosen requirements. Helical and hyperbolic flycutters are representatives of this group.

Helical Flycutters: If the axis of the rotary knife is made parallel to the edge of the bed knife, and if both web motion and rotation of the knife are uniform, the edge of the rotary knife must

Nomenclature

- L = Sheet length, in.
- n = Rotational speed of rotary cutter, rpm
- R = Radius of edge of helical rotary cutter, in.
- s = Web thickness, in.
- t = Length of cutting period, seconds
- t_1 = Length of time for penetration of web, seconds
- u = Distance web travels during cutting period in hyperbolic flycutter, in.
- V_e = Rotary-knife cutter-edge velocity, in./second
- V_w = Web velocity, in./second
- α = Helix angle of edge of rotary cutter, deg
- β = Angle between edge of stationary knife and a perpendicular to web flow, deg
- γ = Angle between web plane, and a plane through edge of stationary knife and axis of helical rotary cutter, deg
- δ = Angle between web plane and plane in which edge of hyperbolic rotary cutter lies, deg
- ϵ = Angle between web plane and a plane through axis of hyperbolic rotary cutter and the point on stationary knife where cutting begins, deg
- θ = Bevel angle of cut edge of web, deg
- λ = Angle of rotation of hyperbolic rotary cutter during cutting operation, deg
- ρ = Radius of edge of hyperbolic rotary cutter at terminal cutting point (*Fig.* 4), in.
- ρ_o = Radius of edge of hyperbolic rotary cutter at initial cutting point, in.
- τ = Angle between perpendicular to plane of web and radius through terminal cutting point on stationary bed knife (*Fig.* 4), deg
- ψ = Projection of web cut-edge bevel angle (θ) to the plane of drawing (*Fig.* 3), deg

Fig. 2—Diagram of helical flycutter. Bed knife is stationary



be a helix, *Fig.* 2. Peripheral speed of the edge of the rotary cutter $V_c = R\ 2\pi n/60$. Since the web advances a distance equal to sheet length L during one revolution of the rotary knife, web speed $V_w = Ln/60$. Assume that cutting begins at point A on the bed knife. By the time the cut is completed, point B_c on the web, where cutting must end, has moved during time t through the distance $B_cB = V_wt$. A point C on the edge of the rotary cutter, which passes point B on the bed knife, travels during the same time t through an arc of length V_ct which, developed in the plane of the web, is equal to the distance BC_c in the drawing. From the geometry of *Fig.* 2

$$\frac{V_c t}{\tan \alpha} = \frac{V_w t}{\sin \beta} \qquad (1)$$

Substituting in this equation the previously obtained values for V_c and V_w yields

$$\sin \beta = \frac{L (\tan \alpha)}{2R\pi} \qquad (2)$$

This relation holds true for any point on the cut edge other than the point where cutting ends; therefore, if the edge of the bed knife is a straight line the developed edge of the rotary knife must also be a straight line, and the shape of the actual knife edge a helix.

For given values of L, γ and α, either angle β or radius R can be chosen. During the cutting period, interference between the advancing web and the rotary knife is avoided if the rotary-knife radius is chosen so that the component of knife-edge velocity ($V_c \sin \gamma$) in the plane of the web is equal to or larger than the component in the same direction of the maximum web velocity ($V_{w\ max} \cos \beta$) which may occur. This maximum web velocity is associated with the largest sheet length for which the cutter is designed. Thus

$$V_c \geq V_{w\ max} \frac{\cos \beta}{\sin \gamma} \qquad (3)$$

Substituting previously obtained expressions for V_w, β and V_w yields the inequality

$$R \geq \frac{L_{max}}{2\pi \sin \gamma} \left[\frac{1}{2} \left(1 + \sqrt{1 - 4 \tan^2 \alpha \sin \gamma} \right) \right]^{\frac{1}{2}} \qquad (4)$$

If the smallest radius value of R is chosen, the tilt angle associated with maximum sheet length can be calculated from the following relationship obtained from Equations 2 and 4

$$\sin 2\beta_{max} = 2 \tan \alpha \sin \gamma \qquad (5)$$

The magnitude of radius R also affects the bevel angle of the cut edge of the web. *Fig.* 3 represents a cross-section perpendicular to the axis of the rotary cutter which shows the relations affecting the bevel angle θ of the cut-sheet edge. From the geometry of this configuration it follows that

Fig. 3—Cross-section of a helical flycutter and web taken perpendicular to the axis of the rotary cutter right auxiliary view. Circle insert shows relation of β, θ and ψ

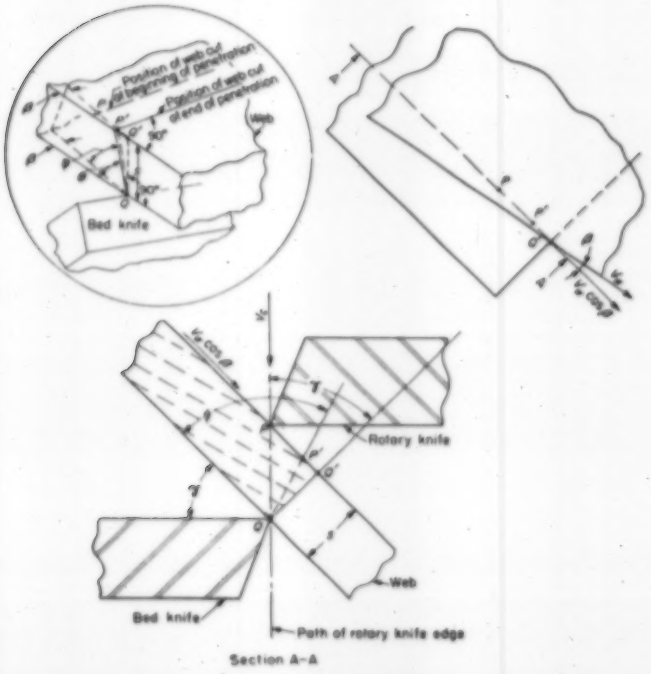


Fig. 4—Diagram of hyperbolic flycutter. Bed knife is stationary

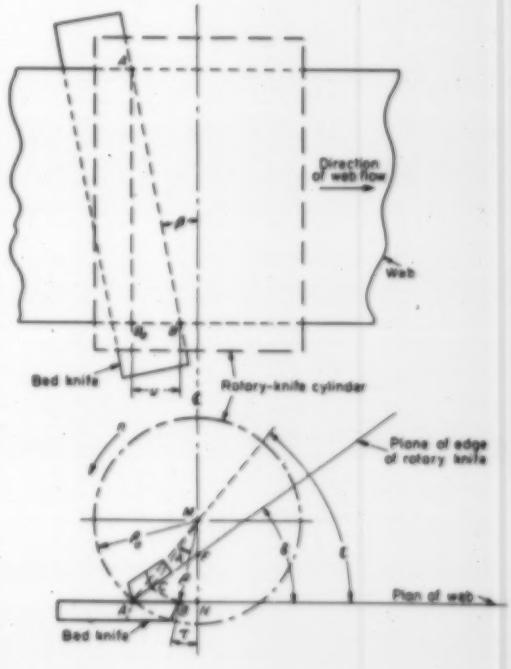


Fig. 5—Diagram of a web cutter with two continuously rotating helical knives

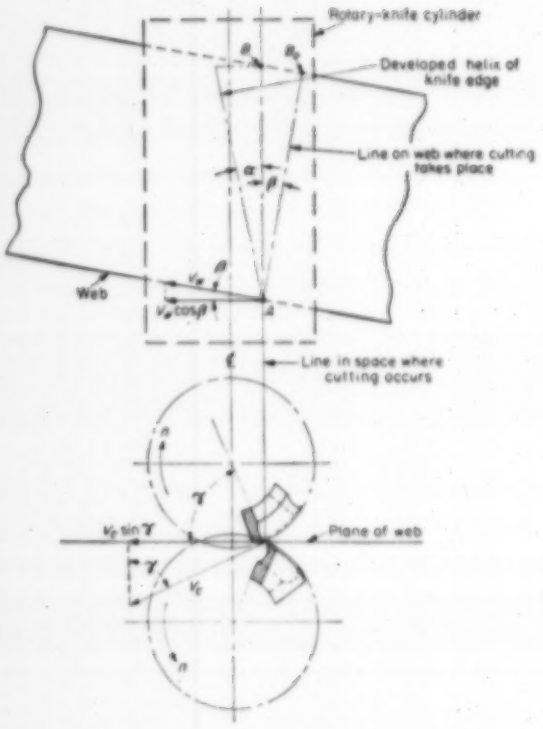

Rotary-knife cylinder
Developed helix of knife edge
Line on web where cutting takes place
Web
Line in space where cutting occurs
Plane of web

Fig. 6—Pair of noncircular gears used for phasing the speed pattern to control speed during the cutting period for continuously rotating helical knives

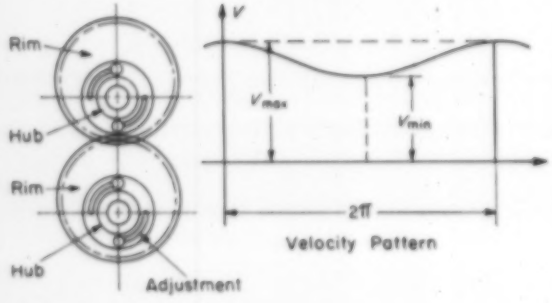
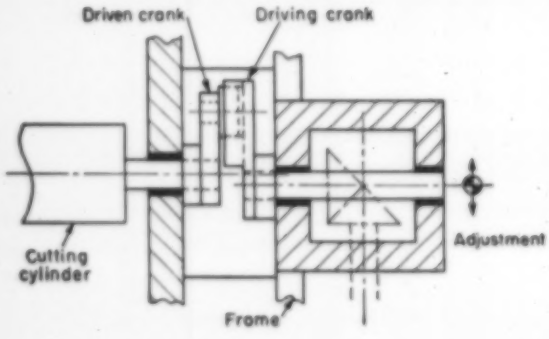


Fig. 7—Whitworth crank—another device for controlling cutter speed



$\tan(90-\psi) = \tan(90-\theta)/\cos\beta$. For a thin web it can be assumed that the edge of the rotary cutter travels on a straight line while penetrating the web; the time for penetration is given by the formula $t_1 = s/(V_c \cos\gamma)$. During the same time the point on the web surface where penetration begins has moved through the distance $PP' = V_w (\cos\beta)/t_1 = s\,V_w \cos\beta/(V_c \cos\gamma)$; from triangle $Q'P'Q$ the distance $P'Q' = s\tan(90-\psi) = s\tan\gamma - sV_w (\cos\beta)/(V_c \cos\gamma)$; substituting the previously obtained value of ψ

$$\tan(90-\theta) = \left(\tan\gamma - \frac{V_w \cos\beta}{V_c \cos\gamma}\right)\cos\beta$$

Substituting for V_w the value $L\,n/60$, and for V_c the minimum value obtained from Equation 4 gives the approximate value of

$$\tan(90-\theta) = \tan\gamma\left(1 - \frac{L}{L_{max}}\right)\cos\beta \quad \ldots\ldots (6)$$

For $L = L_{max}$, the bevel angle of the web becomes 90 degrees if the flycutter is designed with the smallest radius.

The radius R depends primarily on γ; R becomes very large for small values of the angle γ. But for large values of γ the bevel angle of the material being cut becomes small for a sheet length different from the maximum length. Therefore a compromise must be made, and the angle of inclination, γ, is usually about 75 degrees.

A great advantage of the helical flycutter is the simplicity with which it can be adjusted for various sheet lengths; as shown in Equation 3, only angle β must be changed for making this adjustment. Since angle α is small, a small range

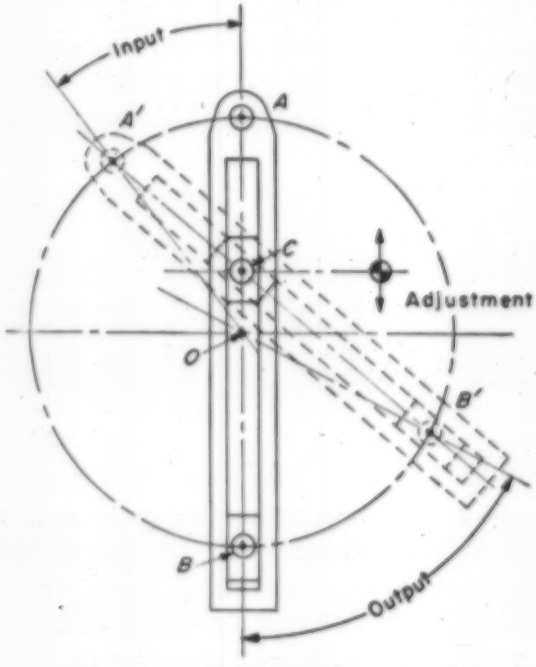


Fig. 8 — Differential crank for changing speed-pattern amplitude

of adjustment of angle β is sufficient to adapt the cutter to large variations in sheet length. Simple devices like a universal joint, a gear coupling, or a pair of spur gears with crowned teeth in the drive of the rotary knife cylinder, which are used in present-day designs, are usually adequate to permit these small adjustments of the tilt angle without affecting accuracy of the cut appreciably.

Hyperbolic Flycutters: A flycutter with a straight bed knife can be so designed that the axis of the rotary knife cylinder is perpendicular to the direction of web flow. As stated previously, the angle between the edge of the bed knife and web flow must be different from 90 degrees. Consequently, the surface generated by the rotation of the bed-knife edge about an axis perpendicular to the direction of web flow, on which the edge of the rotary knife must lie, is a hyperbolic cylinder, and the edge of the rotary knife may be a hyperbola. A hyperbolic edge, being a plane curve, has the advantage that it can be produced with less difficulties than a helical one.

A diagram of a hyperbolic flycutter is shown in *Fig.* 4; it is assumed that the plane in which the edge of the rotary knife lies is parallel to the knife so axis that, in the end view, it appears as a straight line. If the cut must be straight, it is apparent from *Fig.* 4 that the ratio between the web and the knife speed cannot be constant during the cutting period. The cut edge is line AB_o perpendicular to the web flow and cutting begins at point A. The rotary knife is shown in the position when it is passing this point. Point B_o on the web where the cut edge ends must move to point B on the bed knife before cutting at this point occurs. During the same period the point C on the rotary knife which passes through point B must travel through the arc BC. If the corresponding arcs of travel of other points on the rotary knife edge are determined, it will be observed that there is no straight proportionality between the angles corresponding to these arcs and the length of travel of the associated web points to the cutting points on the bed knife.

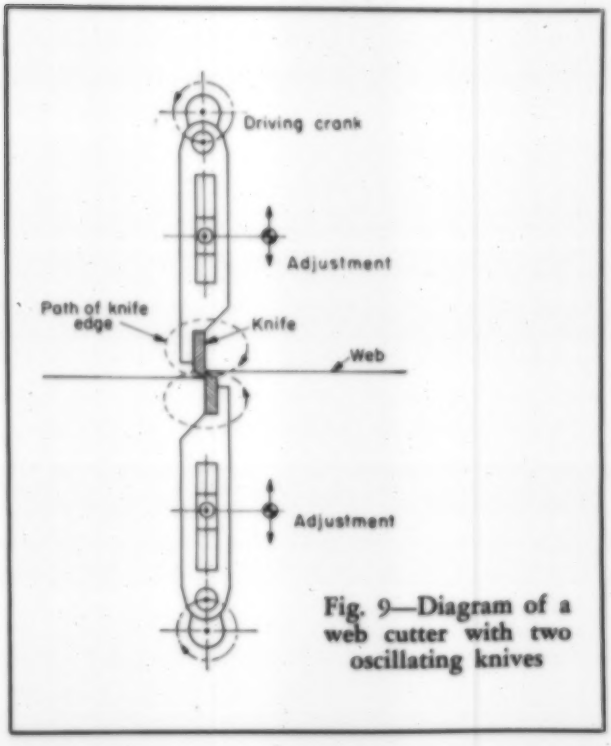


Fig. 9—Diagram of a web cutter with two oscillating knives

The ratios between web and knife speed necessary to obtain a straight cut with a hyperbolic flycutter can be calculated from *Fig.* 4. When cutting has progressed from point A to point B_o on the web, B_o has moved through the distance $u = BB_o$. From triangle BNM in the end view of *Fig.* 4

$$\tau = \tan^{-1} \frac{\rho_o \cos \varepsilon - u}{\rho_o \sin \varepsilon}$$

From triangle AFN in *Fig.* 4 the distance

$$FN = \rho_o \cos \varepsilon \tan \theta$$

From triangle CFM

$$\rho = \frac{\rho_o (\sin \varepsilon - \cos \varepsilon \tan \partial) \cos \varepsilon}{\sin (90 - \gamma - \lambda - \tau)}$$

From triangle ABM

$$\rho^2 = (\rho_o \sin \varepsilon)^2 + (\rho_o \cos \varepsilon - u)^2$$

By substitution and transformation, the following relationship is obtained

$$\lambda = \cos^{-1} \frac{\rho_o \sin (\varepsilon - \delta)}{(\rho_o^2 + u^2 - 2 \rho_o u \cos \varepsilon)^{1/2}} - \tan^{-1} \frac{\rho_o \cos \varepsilon - u}{\rho_o \sin \varepsilon} - \gamma \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

For each point of the bed knife, the associated angle of rotation λ can be calculated from this equation.

Speed variations necessary to obtain these relations can occur either in the rotary cutter or in the web. In the web, speed can be changed easily by means of a loop roller ahead of the cutting unit, the position of which is controlled by a cam rotating at the same speed as the cutter. However, regardless of the width of the web, cutting must always begin at the same point assumed to be the starting point in the calculation.

Radius of the rotary cutter can again be chosen so that the cutter does not interfere with advance of the web during the cutting period, and a similar method for carrying out this calculation can be used as used in the previous case of a helical cutter.

The hyperbolic cutter cannot be adapted to different lengths of the cut-off by simply changing the angle of the unit with respect to the direction of web flow. If this angle were changed, the relation between λ and u would also be changed.

Then it would become necessary to use a different speed-controlling element for every sheet length. This limits the practical use of the hyperbolic flycutter to applications where the sheet length is constant or where tolerances for the properties of the cut edge are not rigorous.

Cutters with Two Continuously-Rotating Knives: A moving web can be accurately sheeted by a pair of uniformly rotating helical knives if the axes of both knife cylinders are parallel to one another, and skewed with respect to a line perpendicular to the direction of web flow. A diagram of such a unit is shown in *Fig.* 5.

The surfaces of the cylinders of radius R described by the rotation of the helical knife edges intersect along a line AB which must be parallel to their axes. On this line cutting must occur, and the web must pass through it. Consequently, this line is in the same position, relative to the rotary cutters, as the edge of the bed knife is in the fly-cutter unit, and identical relations between sheet length, helix angle, tilt angle of the cutter unit, and radius of the rotary-knife edges must exist.

It should be noted that theoretically one of the two knife cylinders can have a smaller radius than the other; such a unit would still produce a straight cut by proper selection of helix angles and knife velocities. It can be concluded that the helical flycutter is only a special case of the cutter with two helical rotary knives in which the radius of one knife cylinder is equal to zero.

Adjustment of the unit for different sheet lengths can be made, in the same way as in the case of a helical fly cutter, by changing its tilt angle. Instead, this adaptation can be made by varying the cutter speed during the cutting period; this is also true of the helical fly cutter. Several ingenious mechanisms have been devised to obtain such speed variations. The cutting period is usually a very small portion of the cycle (only a few degrees); the cutter speed before and after this period has little effect on the performance of the sheeter, which gives the designer considerable leeway. In one device of this kind, the cutting cylinder rotates continuously at a nonuniform speed such that the same speed pattern is repeated during every cycle. The adjustment to the speed of the web associated with desired sheet length is made by changing the phasing of the speed pattern so that the desired speed occurs during the cutting period. The nonuniform speed pattern is, for instance, obtained by a pair of noncircular gears, and the phase is controlled by adjusting the position of the rims of these gears on their hubs *Fig.* 6. Adjustment of the phasing can also be obtained by providing a miter-gear differential between the cutting cylinder and the driven noncircular gear along with a means for rotating the housing of this differential drive.

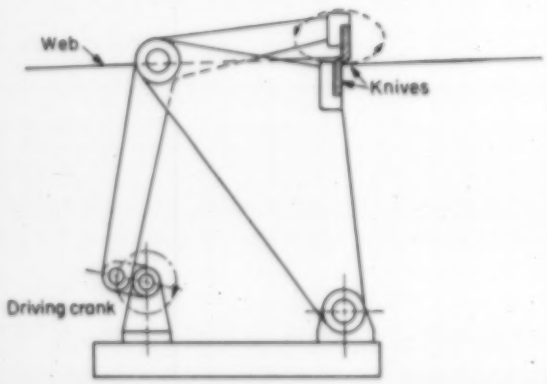
In other devices, adaptations of the cutter speed are made by changing the amplitude of cyclic speed variations. In one mechanism of this kind, the well-known Whitworth crank is used, *Fig.* 7. A shoe pivoting on the driven crank engages a slot in the driving crank which is mounted in a housing, the position of which is adjustable on the frame. Another cutter design makes use of a differential crank, *Fig.* 8. The driving crank OA is attached to one end of a slotted lever AB. The driven crank OB which is concentric to OA engages the other end of this lever by means of a shoe. The slot of the lever is also engaged by a shoe pivoting about a pin C on the frame. Position of this pin can be adjusted to change the amplitude of the speed pattern. Since the cutting period is a short part of the whole cycle, slight changes in cutter speed during this period have little practical significance.

If the edges of the two rotary knives are hyperbolic, action of the cutting unit will be similar to that of the hyperbolic flycutter, and relations derived for the hyperbolic flycutter are equally applicable to such a unit.

Cutters with Two Oscillating Knives: Cutters where both knives oscillate have the advantage that knives with straight edges can be used. While penetrating the web, these knives must move at web velocity; their speed must be adjustable for the cut-off length. Typical design of such a cutter is shown in *Fig.* 9. The knives are attached to one end of levers. The other ends of levers pivot on a drive crank. Shoes which engage slots in these levers are pivoted on blocks on the frame, and the position of these blocks is adjustable so that the ratio between crank speed and knife speed can be varied as needed.

Another design of a cutting unit of this type is shown in *Fig.* 10. This mechanism is basically a four-bar linkage in which one knife is attached to the control arm while the other knife is attached to an extension of the coupler at the same distance from the common pivot of these links as the first knife. This cutter can be adjusted to various sheet lengths by providing in the drive one of the previously described mechanisms for varying the angular velocity during a cycle.

Fig. 10—Oscillating-knife flycutter with four-bar linkage to control knife motion



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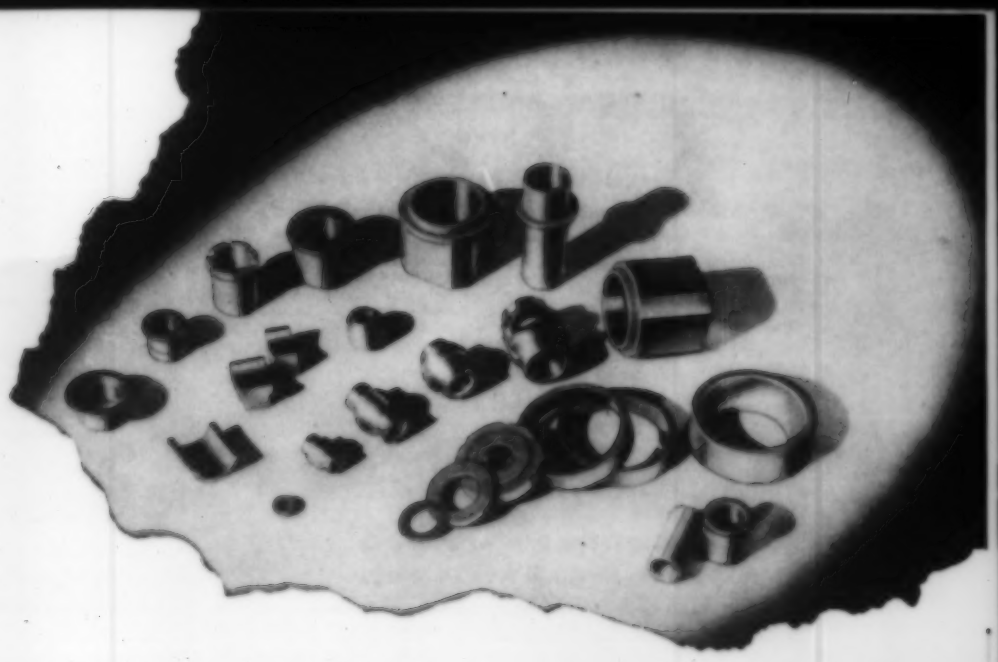


Design and Application of

Powder-Metal Bearings

SLEEVE or journal bearings made of porous bronze were originally developed for applications where oil supply was a problem. In a remote location within a machine these bearings, with their own oil supply, solved problems of oiling and maintenance. An early application of porous bronze bearings that is still popular is found in automotive water pumps.

Cost: After a few years of experience it became apparent that the methods of powder metallurgy offered a distinct cost advantage in many instances. Relatively complicated shapes and small sizes can be manufactured by the following steps: (1) Briquette, (2) sinter, (3) dip in hot oil, (4) size, and (5) soak in hot oil.

Although die cost is high and the powder is relatively expensive as compared to cast bronze, this is often offset by machining cost savings. Thus many parts have been manufactured by this method because of the cost advantage.

Many technological advances have been made in porous bronze bearings, and better powders are now being produced on a large scale. Present-day powders have higher green strength after briquetting, better flow into the dies, and more reproducible growth characteristics during sintering. The sintered and sized parts can be consistently manufactured to specified tolerances as well as to specifications for density, porosity, oil retention and strength. Because of good process control, parts are to close dimensions at low cost.

In addition to the 90-10 copper-tin alloy which is often used, high-strength, low-cost iron, iron-copper alloys and other alloys are now being widely applied.

In a large percentage of applications, bearings made by this method are used simply because of the price advantage, especially where the requirements are for low cost, dimensional tolerance and strength. Where cost is the primary factor, the self-lubricating properties may become secondary or even unimportant. However, in many applications the unique properties of the metal sponge structure are a distinct advantage. On the other hand limitations of the process and the product define the design characteristics.

PV Factor: All bearings have performance limits for load, speed, clearance, misalignment, corrosion and fatigue. In many cases these limits cannot be easily defined because of a great diversity and complexity of applications. However, for bronze bearings such factors as fatigue and corrosion are

Table 1—Permissible Powder-Metal Sleeve-Bearing Loads

Shaft Velocity (fpm)	Permissible Load (psi) Bronze	Iron Alloys
Slow and intermittent	4000	5000
25	3000	3000
50 to 100	500	700
100 to 150	325	400
150 to 200	250	300

Table 2—Permissible Total Loads for Powder-Metal Sleeve Bearings

Speed (rpm)	Total Load (lb) for Sleeve Bearing Length of ¼-in.	½-in.	¾-in.	1 in.	1½ in.	2 in.	2½ in.	3 in.
100	480	960	1420	1900	2850	3800	4750	5700
200	240	480	710	960	1420	1900	2400	2900
300	160	320	480	640	960	1270	1600	1900
400	120	240	360	480	720	960	1200	1450
500	95	190	290	380	570	760	950	1150
600	80	160	240	320	480	640	800	950
700	70	140	200	270	410	540	690	820
800	60	120	180	240	360	480	600	720
900	53	106	160	210	320	420	540	640
1000	48	96	140	190	280	380	480	570
2000	24	48	70	100	140	190	240	290
5000	10	19	29	38	57	76	100	120
10,000	5	10	14	19	28	38	48	57

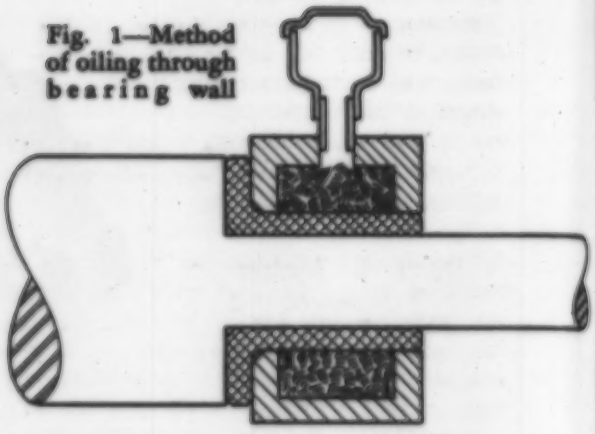


Fig. 1—Method of oiling through bearing wall

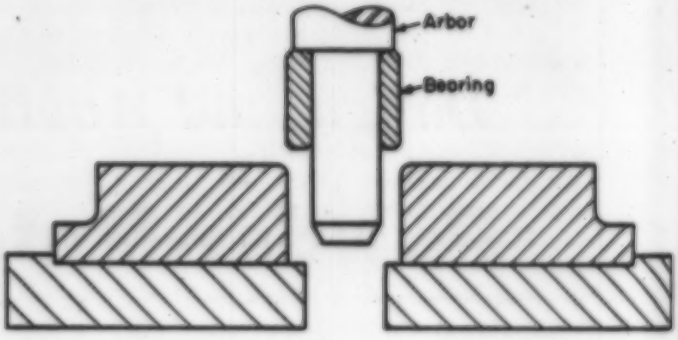


Fig. 2—Pressing a straight sleeve bearing into place with a shouldered arbor

not common limitations. In almost all applications, life is determined by the rate of wear, and performance is governed by the original fit. Consequently, it is possible to define the limitations by the formula $PV = K$ where P = unit load on projected bearing area (length times diameter), psi; and V = surface velocity, fpm. For bronze, $K = 50{,}000$. This factor is commercially specified and accepted. A convenient form for the preceding formula is

$$W = \frac{12KL}{N}$$

where W = bearing length, inches; and N = shaft speed, rpm. The bearing diameter does not appear in the preceding equation because the surface speed and the projected area are both directly proportional to the diameter. However, unit loading is inversely proportional to the shaft diameter for the same bearing length.

Commercially accepted velocities and permissible loads recommended by an ASTM committee are given in *Table* 1. Where shaft deflection or imperfect alignment are factors, permissible loads will be lower.

Table 2 lists the total load in pounds that may be supported by common bearing lengths for various shaft speeds where $PV = 50{,}000$. For iron alloys, a K value of 75,000 is accepted, meaning that the loads may be 50 per cent higher than those recommended as a limitation for bronze. However, it should be kept in mind that bronze possesses better bearing properties than iron and is preferred for high-speed applications. Iron alloys are generally preferred for lower cost or higher loads at low speeds.

Lubrication: For most applications oil is supplied to the bearing surface by conventional oiling methods so that a reserve of oil is available in addition to the oil retained in the pores. For such applications the recommended criterion for the load times speed product is safe. Laboratory tests have demonstrated that, in the absence of an adequate oil supply, a PV value much lower than 50,000 is necessary to avoid overheating and grabbing of the shaft.

However, there are many applications, such as electric-clock motors and refrigerators where bearings will run until worn out on the original oil retained in the pores. If the loads are sufficiently low, long life may be expected without periodic oiling at moderate speeds. Also, if operation is not continuous, as in automatic washing machines, then higher loads may be used with limited lubrication. In addition the oil may be sealed in for washing machines or small electric motors to assure an adequacy of oil and obtain lifetime lubrication. Thus advantage is taken of the porous wall as an aid to lubrication. Porosity is specified in the range of 18 to 25 per cent, and oil will pass through the wall, *Fig.* 1. Any method of increasing the oil reservoir so that oil is circulated through the bear-

ing by natural pumping action will result in lower operating temperatures.

Because of the porous surface a thick oil film cannot be built up during operation. The bearings then are essentially operating under boundary lubricating conditions at all times. This means that the extremes of operating conditions will be best tolerated with a good shaft finish, good surface contact, and low clearance.

Tolerances: Specifications for *PV* values, bearing sizes, fits, tolerances, and running clearances are being established by ASTM. As a general rule, minimum running clearances of 0.001-inch per inch of shaft diameter are recommended. A minimum press fit of 0.001-inch is recommended for bushings up to $\frac{5}{8}$-inch diameter, 0.0015-inch up to 1-inch and 0.002-inch up to 2 inches diameter. These limits are necessary to allow for normal commercial size tolerances of the shaft, the housing, and the bearing wall thickness as well as dimensional changes due to press fitting. Shaft finishes of 5 to 10 microinches are desirable.

For optimum operating conditions, good fits and surface finishes are necessary to take full advantage of thin-film lubrication. If the load is not properly distributed, overheating will cause carbonization of the oil, loss of local lubrication and resultant grabbing of the shaft. In fact the operating temperature measured at the back of the bearing is a good criterion of performance. Bearings will run satisfactorily up to 175 F, but higher temperatures indicate a bearing surface temperature above the safe operating range.

Proper alignment during installation and align boring or burnishing after installation are essential in order to avoid edge loading.

For press fitting, a shouldered arbor is recommended, *Fig.* 2. After a nominal press fit, the bearing can be burnished to size. Burnishing stock of 0.001 to 0.003-inch has been successfully used to produce properly sized holes. Where alignment with another bearing is required, either boring, pilot burnishing or pilot reaming is necessary. The best reaming results have been obtained with a spiral reamer.

Sizing methods result in some loss of surface porosity. Consequently a bearing size should be selected so that a minimum of stock will be displaced or removed during finishing or sizing operations.

Hand push-fits are not common, but in a few cases they have been used for precision bearings and ease of assembly. In such cases the bearing is anchored with a pin or retaining rings.

Vibration: In some assemblies vibration has proved to be a limiting factor. Whether it is caused by the bearing and shaft relationship or some other element of the machine, it has resulted in restriction of load capacity.

Sizes: Porous metal bearings are available in a great many stock sizes to satisfy a number of applications. These stock sizes are manufactured to commonly accepted commercial tolerances. Where custom bearings are desired, there are limitations on the manufacturing process that should be taken into account. Design for liberal tolerances will avoid costly gaging procedures.

Shapes: Simple shapes that can be pressed with dies can be manufactured in a few steps. Any design requiring holes in the wall or re-entrant angles will require extra punching, drilling, sizing or machining steps. Simple cylindrical bearings, *Fig.* 3, flanged bearings, and spherical (self-aligning) bearings, *Fig.* 4, are easily made. On the other hand, a double-flanged bearing can only be made

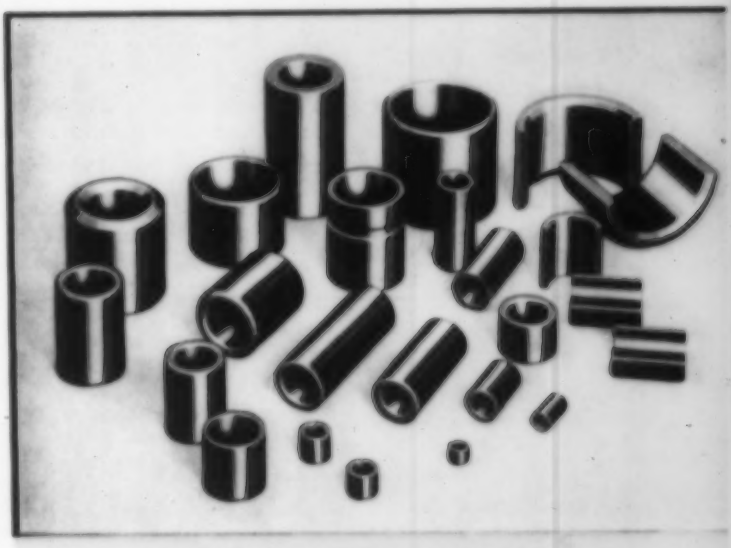
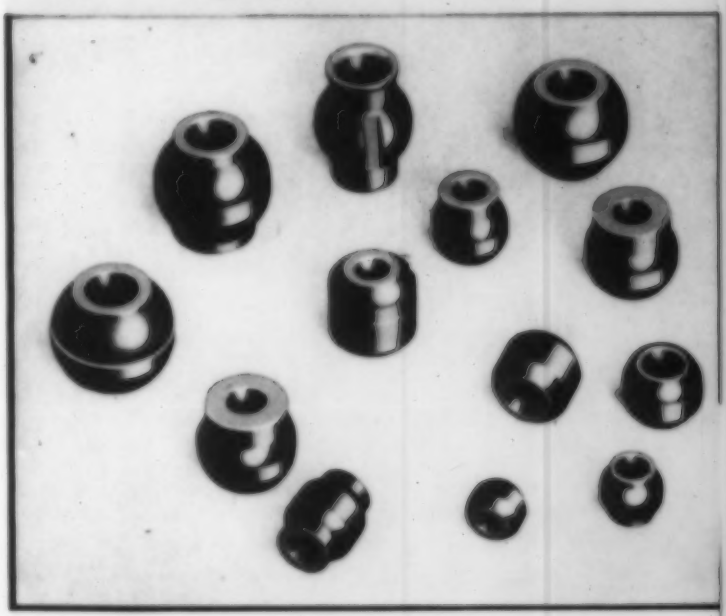
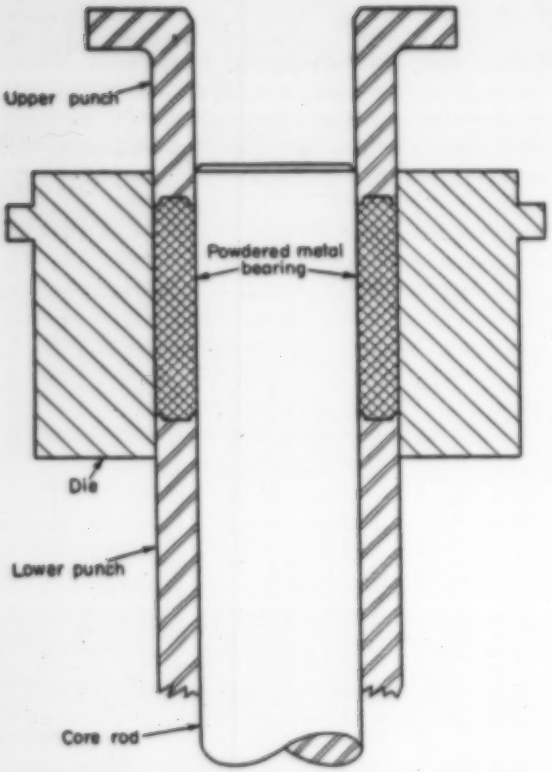


Fig. 3—Above—Simple, easily manufactured powder-metal bearings

Fig. 4 — Below — Self-aligning spherical bearings





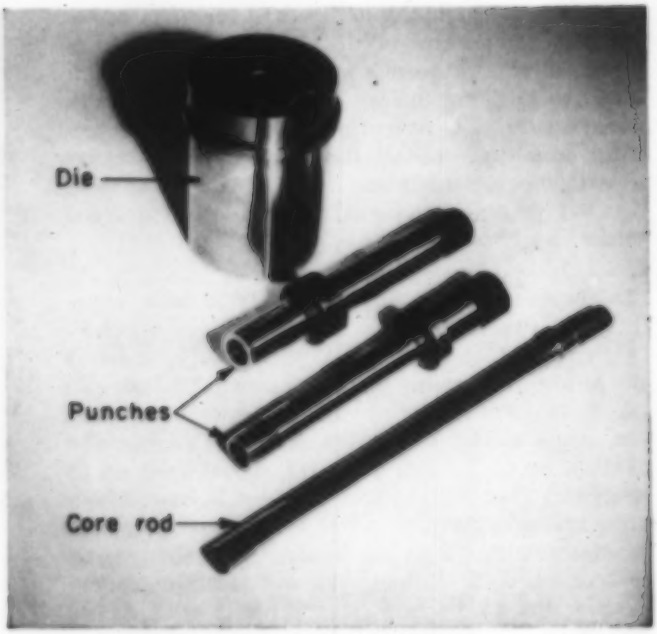


Fig. 5—Die, punches and core rod used for making a cylindrical bearing and method of forming

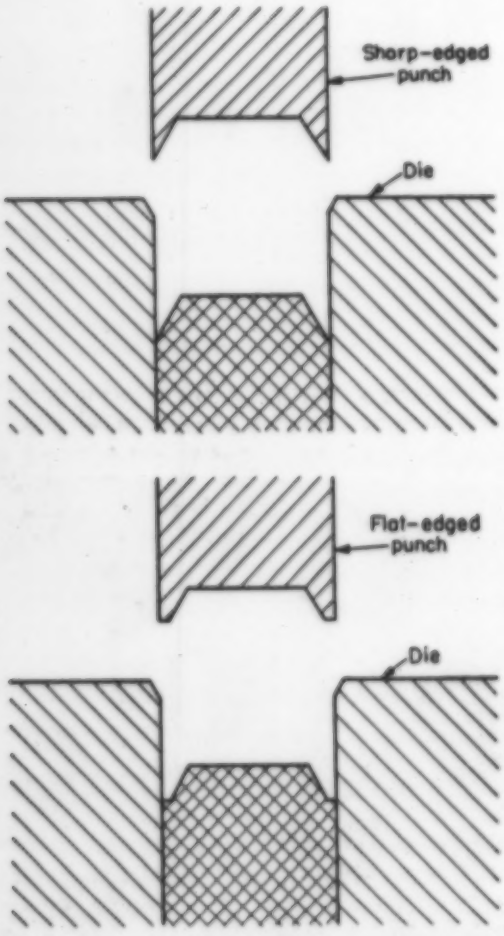


Fig. 6—Left—Formation of bearing chamfer with sharp edged punch and long-life flat-edged punch

by machining away a considerable amount of stock between the flanges.

Complicated shapes can be made as long as they are extractable from the die. Close tolerances, better surface finish and modification of the shape can be obtained in the coining operation. However, the shape cannot be radically changed in this step due to the limitations of excessive pressure required as well as the strength of the material.

Porosity: If it is essential to retain porosity, then relative dimensions are restricted. *Fig. 5* shows a bearing being formed by the use of a core rod and an upper and lower punch. The powder flows readily under the influence of slight pressure. However, as it begins to densify, the ability to transmit pressure through the compacted powder is restricted in long sections because of wall friction. Consequently the powder will densify at each end. This results in loss of porosity at the ends and loss of strength at the center. In general, bearings with a length greater than three times the shaft diameter should not be specified. Thin sections should be avoided as well as abrupt

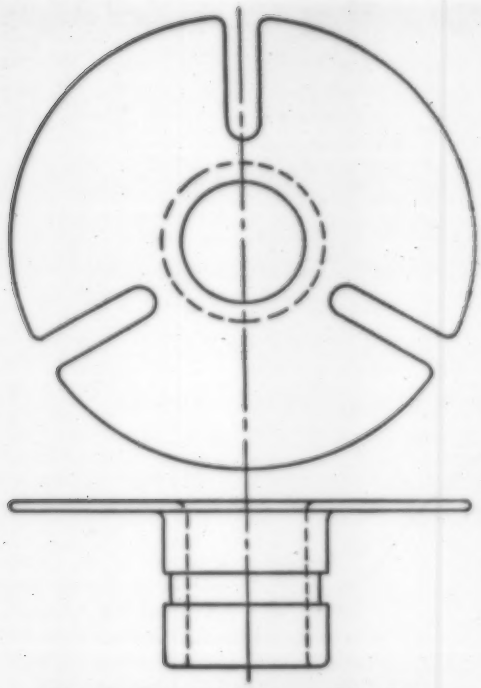


Fig. 7—Part with large thin flange attached to small body with deep slots and groove in OD of body. These design characteristics should all be avoided in powder-metal parts

changes in wall thickness or uneven cross sections, since they cause considerable difficulty in sizing. Such sizing difficulties result in distortion and the formation of weakened areas.

Other Design Factors: Porous bronze bearing design should also take die design into account. *Fig.* 6 shows a sharp-edged punch and a punch with the minimum recommended 0.005-inch land. High pressures and abrasive action of the metal powders bring about low tool life for any sharp or thin edges. All briquetted parts should be made with chamfered edges and all internal angles should be provided with fillets so as to avoid burrs.

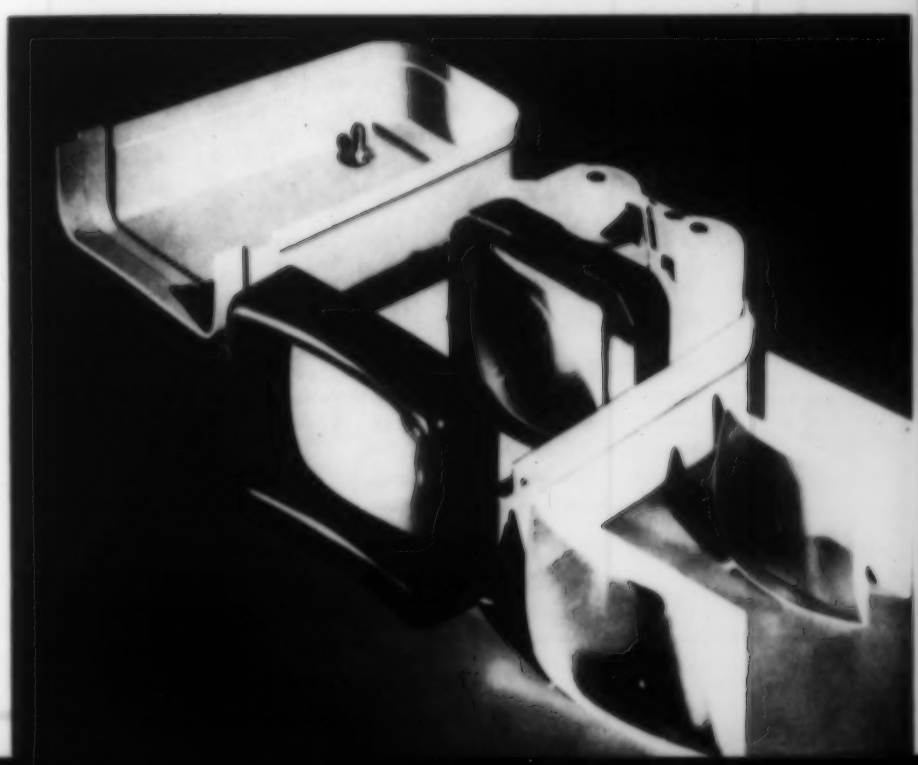
Spherical bearings, *Fig.* 4, require a flat on the OD at least 3/32-inch wide to prolong tool life. Flange bearings should be designed with a generous fillet under the flange to obtain a strong part and minimize briquetting troubles.

In *Fig.* 7 are shown design conditions to be avoided, such as deep slots, an oil groove around the periphery or a large, thin flange. If a large, thin flange is required with respect to a body, it is much better to design for a separate thrust washer and a straight bearing. Likewise if a long bearing is required it may be better to use two shorter bearings. Counterbores, recesses and bosses should be kept as shallow as possible and should be specified with a sufficient taper to be withdrawn from the dies.

Contemporary Design

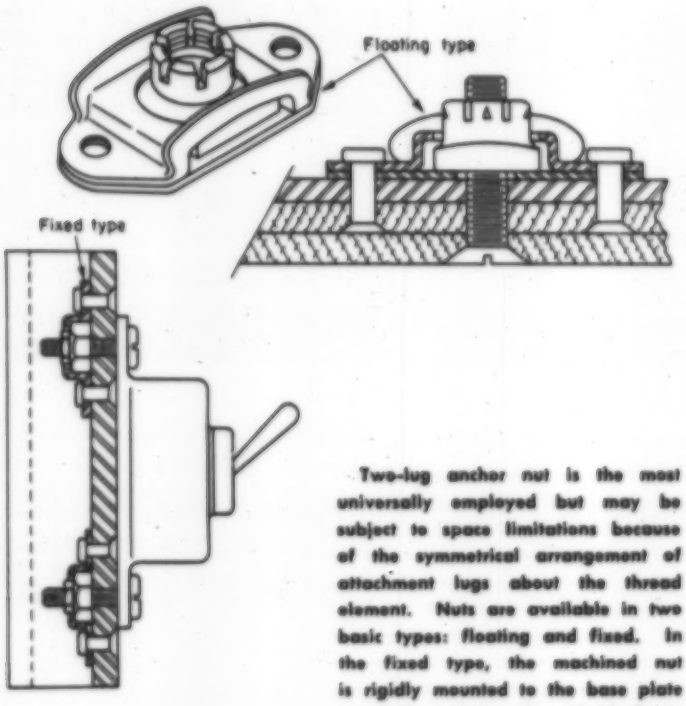
Slide Viewer Has Acrylic Lenses

ACRYLIC plastic, used to make the lenses of a new 35-mm slide viewer, is said to offer considerable saving over the more usual optical glass lenses. Key to the saving is the required grinding time. The hour-long grinding operation with glass is reduced to two minutes with acrylic Plexiglas. Primary lens of the Opta-Vue unit made by Optics Mfg. Co., is generated from 0.500-in. sheet; the secondary lens from 0.625-in. material. Dimensions of the two lenses are 1¾ by 2 and 2 by 3 in. respectively. Integral batteries provide power for a viewing light source. Linear magnification of the slide being viewed is 5x with the viewer held directly in front of the eyes; area magnification is 9x with the viewer 18 in. from the eyes.

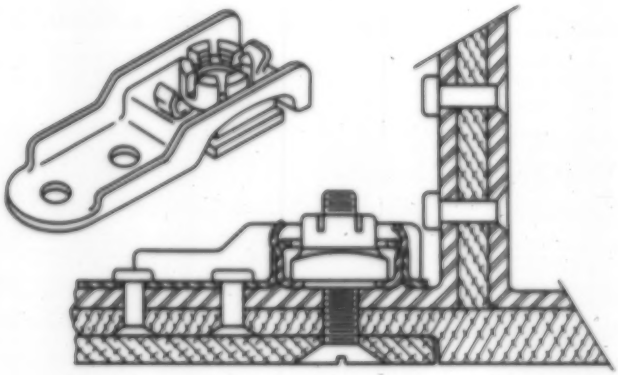


Anchor Nuts

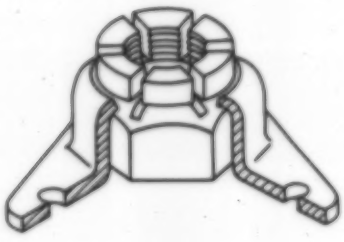
Primary function of the anchor or, as it is sometimes called, plate nut is to provide a permanent nut attachment for assembly of threaded fastener elements. Several types, sizes and shapes of nut designs are available but all consist essentially of a machined nut mounted in a sheet metal shell or retainer which can be securely attached to the base machine structure by welding, riveting or other similar methods. As a result, these nuts are eminently suited for three general kinds of applications: (1) Panel and equipment assemblies or subassemblies where periodic removal for inspection or maintenance is necessary, (2) machine structures in which the nut will be relatively inaccessible for wrenching or difficult to assemble, and (3) subassemblies which would be functionally affected by a base nut becoming lodged in the mechanism. Typical types and applications of anchor nuts manufactured by the Nut-Shel Co. are shown in the accompanying illustrations. All of these designs are of the aircraft self-locking type.

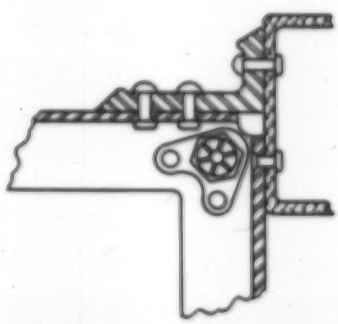


Two-lug anchor nut is the most universally employed but may be subject to space limitations because of the symmetrical arrangement of attachment lugs about the thread element. Nuts are available in two basic types: floating and fixed. In the fixed type, the machined nut is rigidly mounted to the base plate or shell and is, thus, held firmly in place after attachment. The toggle switch assembly, for example, utilizes two miniature fixed type nuts for mounting. In the floating type, however, the machined nut is loosely mounted in the shell or retainer and can move or "float" to accommodate a limited degree of misalignment in assembly.



One-lug anchor nut is useful where space limitations require installation of a threaded element close to a flange or other surface discontinuity. It is also suitable where the width allowance for attachment is restricted. Nuts shown are of the floating type; however, fixed types are also available.





Corner anchor nut is generally employed on corner locations in assemblies where a series of uniformly-spaced thread elements is required. Structural access doors, for example, are typical applications.

How to perform a

VIBRATION ANALYSIS

A logical step-by-step method for solving machine vibration problems and selecting isolator properties and locations

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NECESSITY for isolating undesired machinery vibrations from adjacent structures is widely recognized. A popular method of reducing the disturbance is the use of resilient members, or isolators, between the machine and its supporting foundation. In many applications, isolators are selected by a cut-and-try method until sufficient vibration attenuation is achieved or until the experimenter convinces himself that no satisfactory or inexpensive vibration control system is possible. However, since most designers are acquainted with the fundamentals of vibrating systems, most isolators are chosen on the basis of vertical (single degree of freedom) vibration transmission. Nevertheless, costly installations are still obtained. One reason for these results is that only a few of the factors contributing to vibration control are considered. leaving others to chance.

This article will present, as far as possible, all the pertinent factors involved in solving the most common type of machinery vibration problem, that caused by the steady-state application of alternating forces and torques on the machine. The pertinent factors involved are the basic dynamic properties of the vibration mounts and the machine.

Intent is to assist machine designers familiar with fundamental vibration theory[1-3] to select or to evaluate vibration isolators with less guess-

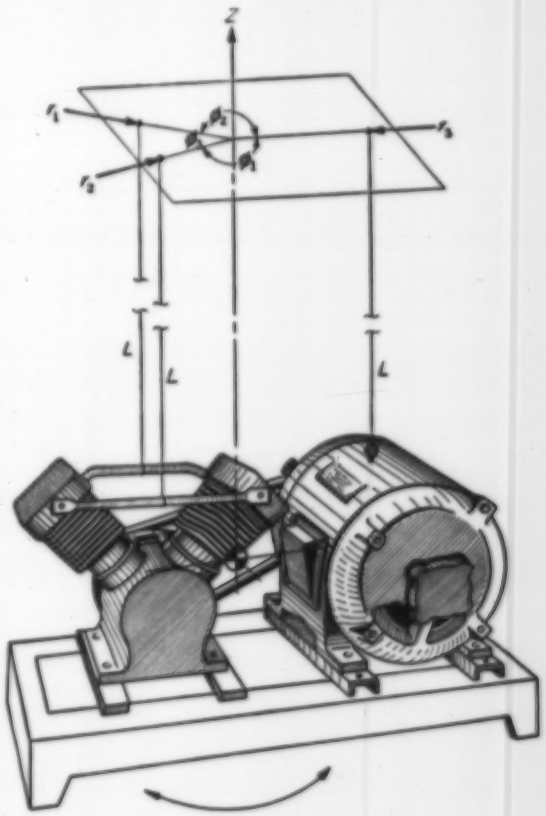


Fig. 1—Three-wire method of determining moment of inertia about the Z axis

*Formerly with Armour Research Foundation, Chicago, Ill.
[1]References are tabulated at end of article.

work or risk and, in some cases, to predict the amount of transmitted vibration before the machine is installed. Although most of the information is scattered throughout various texts on the subjects, this article is the first continuous discussion of the problem, as far as can be determined.

A step-by-step analytical procedure can be used for selecting resilient mounts to achieve the best isolation, or for determining the magnitude of transmitted vibrations, if the isolators have already been chosen. The method of performing this analysis consists of:

1. Finding the directions, points of application and frequencies of impressed vibrational forces and torques.
2. Establishing the machine weight, location of its center of gravity, and moments and prod-

Nomenclature

A_x = Amplitude factor in the X direction
A_α = Amplitude factor in rotation about the Y axis
a = Distance from resilient mount to the XZ reference plane, inches
b = Distance from resilient mounts to the YZ reference plane, inches
c = Viscous damping coefficient of mounting, lb-second per inch
c_c = Critical damping coefficient, lb-second per inch
$= 2\,(Km)^{1/2}$
c_x, c_y, c_z = Viscous damping coefficient of resilient mounts in the X, Y and Z directions, lb-second per inch
D, D^2 = Differential operators d/dt and d^2/dt^2, respectively
F_c = Impressed centrifugal force of rotating members, lb
F_o = Impressed vibrational force for single degree of freedom system, lb
F_r = Impressed inertia force of reciprocating parts, lb
F_t = Transmitted vibrational force for single degree of freedom system, lb
F_{tx}, F_{ty}, F_{tz} = Transmitted vibrational force in X, Y and Z directions, lb
F_x, F_y, F_z = Component of impressed vibrating force in X, Y and Z directions, lb
f_o = Frequency of oscillation about axis of rotation, revolutions per second
h = Distance from resilient mounts to XY reference plane, inches
I_o = Polar moment of inertia about axis of rotation, lb-in.-second^2
I_x, I_y, I_z = Polar moment of inertia about X, Y and Z axes, lb-in.-second^2
I_{xy}, I_{xz}, I_{yz} = Product of inertia about XZ and YZ, XY and YZ, and XY and XZ reference planes, respectively, lb-in.-second^2
K = Dynamic spring rate of mount, lb per inch
K_x, K_y, K_z = Dynamic spring rates of resilient mounts in X, Y and Z directions, lb per inch
L = Length of suspension wires; distance from rotational axis to reference axis, inches
l = Length of connecting rod, inches
M_{ta} = Transmitted vibrating moment, lb-in.
m = Mass of machine, lb-second^2 per inch
m_r, m_t = Total mass of rotating members and reciprocating parts, respectively, lb-second^2 per inch
P = Gas force on piston, lb
R_y = Radius of gyration around Y axis, inches
r = Crank radius, inches
r_1, r_2, r_3 = Distance from reference axes to suspension wires, inches
r' = Equivalent radius of rotating members, inches
s = Distance from crosshead to crankshaft, inches
T = Transmissibility
T_x, T_z, T_m = Horizontal, vertical and moment transmissibility, respectively
t = Time, seconds
x_o = Displacement (single) amplitude in X direction, inches.
x, y, z = Instantaneous translational displacement of the machine center of gravity in the X, Y and Z directions, inches
x_r, y_r, z_r = Distance from application point of rotating force to the YZ, XZ and XY reference planes, respectively, inches
α, β, γ = Instantaneous rotational displacement of machine about the Y, Z and X axes, respectively, radians
α_o = Displacement (single) amplitude about Y axis, radians.
θ = Electrical phase angle, radians
Σ = Summation
τ = Instantaneous impressed total torque, lb-in.
τ_h = Instantaneous impressed torque about horizontal axis, lb-in.
τ_o = Impressed oscillating torque, lb-in.
τ_x, τ_y, τ_z = Component of impressed vibrating torque about X, Y and Z axes, lb-in.
ϕ = Angle between connecting rod and crosshead, radians
ϕ_1, ϕ_2, ϕ_3 = Angles between Z-axis intersection with reference plane and wire suspension points, radians
Ω = Firing frequency (impressed vibrational frequency), radians per second
ω = Impressed vibrational frequency, radians per second
ω_e = Electrical frequency, radians per second
ω_n = Undamped natural frequency for single degree of freedom system, radians per second
$= (K/m)^{1/2}$
ω_z = Undamped natural frequency for vertical mode, radians per second
$= (\Sigma K_z/m)^{1/2}$

ucts of inertia about three mutually perpendicular references axes through the center of gravity.

3. Determining location of the resilient mounts relative to the reference axes, and if the mounts have already been selected, their dynamic spring rates and damping ratios.
4. Setting up a diagrammatic model of the vibrating machine.
5. Applying the equations of motion to the system.
6. Determining the transmissibilities, so that the mount characteristics can be selected to give good vibration control, or if the isolators have already been chosen, so that the magnitude of the transmitted vibrations can be ascertained.

Details of the step-by-step method will be outlined in the following sections.

STEP 1— Determining Impressed Forces and Torques

Characteristics of the vibration-generating forces and torques necessary to the vibration analysis are their directions, points of application, frequencies, and sometimes magnitudes. To discuss these characteristics, two machines which commonly cause vibrational disturbances will be investigated. In *Example* 1, a typical determination for a motor-generator set is outlined; in *Example* 2, the method for a single-cylinder engine is analyzed.

An analysis of the impressed forces and torques

Example 1—Determining Impressed Forces and Torques: Motor-Generator Set

A TYPICAL example of electrical machinery problems is the motor-generator set shown. Slight unbalance of the armature creates a centrifugal force F_c which rotates at the shaft speed ω (radians per unit time), which is the impressed frequency. The instantaneous centrifugal force can be considered a concentrated force acting at one point, as shown. Forces and torques impressed on the machine frame by the centrifugal force can be derived from the drawing as

$$F_x = F_c \cos \omega t \quad (1.1)$$

$$F_y = 0 \quad (1.2)$$

$$F_z = F_c \sin \omega t \quad (1.3)$$

$$\tau_x = F_c\, y_r \sin \omega t \quad (1.4)$$

$$\tau_y = F_c\, (x_r \sin \omega t - z_r \cos \omega t) \quad (1.5)$$

$$\tau_z = -F_c\, y_r \cos \omega t \quad (1.6)$$

Forces are positive in the directions indicated. Counterclockwise torques are considered positive.

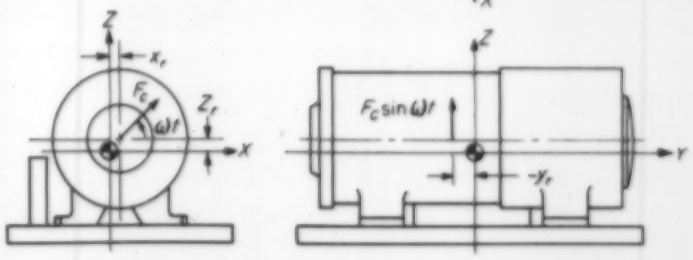
Although magnitude of the centrifugal force need not be determined, it is interesting to observe that it depends not only on the shaft speed, but on the magnetic field as well. The slight rotor deflection caused by centrifugal force produces a smaller gap between the rotor and the stator windings on one side, and a larger gap on the other side. The smaller gap results in a stronger magnetic pull, tending to bend the shaft even more and, additionally, increasing centrifugal force.

Another form of motor or generator vibration caused by the magnetic field, is an oscillating torque τ_o about the shaft axis. As derived for ac applications,[1] the torque τ_y about the Y axis is

$$\tau_y = \tau_o \cos (2\,\omega_e t - \theta) \quad (1.7)$$

The equation shows that the impressed vibrational frequency ($2\omega_e$) is twice the electrical frequency, an important factor to consider when isolating ac electrical machinery. For dc installations, the torque frequency can be computed by multiplying the number of poles by the shaft speed.

Since the oscillating torque τ_o and the centrifugal force F_c act simultaneously on the motor-generator set, Equations 1.5 and 1.7 should be combined. However, if the two frequencies, ω and $2\omega_e$ are not equal (which is usually the case), then the problem can be solved by considering the forcing function at each frequency individually.



of just a few of the wide variety of vibration-generating machines would require considerable space, and therefore will not be further discussed here. Multicylinder engines, especially, necessitate a thorough investigation of the motion of their many reciprocating and rotating members, some of which may be either partially or completely balanced. However, several excellent textbooks and articles[1-5] outline machinery analytical techniques and present practical examples.

STEP 2— Finding Machine Characteristics

To determine vibrational performance of a machine, three characteristics of the machine must be established. They are (1) the machine weight, (2) location of the center of gravity, and (3) moments of inertia and products of inertia about three mutually perpendicular reference axes through the center of gravity. These can be determined by estimation, calculation or test. Experimental determination is usually more accurate than the other methods, and should therefore receive primary consideration.

Center of Gravity and Moments of Inertia: Experimentally locating the center of gravity is usually a simple procedure.[6] Finding the moments of inertia, however, is a more difficult matter. Although they can be estimated, the polar moments of inertia (I_x, I_y, I_z) can usually be obtained rather easily by experimental means if the machine is not too large. One satisfactory method is that of suspending the machine with three equal-length wires, *Fig.* 1, and utilizing

$$I_z = \frac{WR^2}{4\pi^2 f_0^2 L} \qquad (1)$$

where

Example 2—Determining Impressed Forces and Torques: Single-Cylinder Engine

RECIPROCATING machine members often generate forces and torques of large magnitudes. As an example, consider the single-cylinder horizontal engine shown. Forces F_r and F_c are impressed on the machine at the main bearings.[2] Inertia force F_r of the reciprocating parts is given by

$$F_r = m_1 r \omega^2$$

while the centrifugal force F_c of the rotating counterbalance is

$$F_c = m_r r' \omega^2$$

Thus the force components in the X, Y and Z directions are

$$F_x = F_r \left(\cos \omega t + \frac{r}{l} \cos 2\omega t\right) - F_c \cos \omega t \qquad (2.1)$$

$$F_y = 0 \qquad (2.2)$$

$$F_z = -F_c \sin \omega t \qquad (2.3)$$

In Equation 2.1, impressed frequencies higher than the second harmonic, i.e., the "(r/l) cos $2\omega t$" term, can be considered negligible.[2]

The engine must generate a torque to drive its load. However, oscillating components as well as a constant component are developed. For a single cylinder, the total instantaneous torque τ can be found by[3]

$$\tau = \left[P + F_r \left(\cos \omega t + \frac{r}{l} \cos 2\omega t\right)\right] s \tan \phi$$

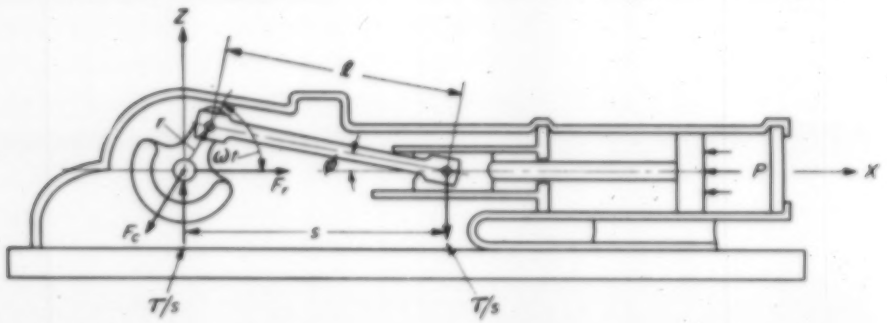
where

$$\tan \phi \approx \frac{r}{l} \frac{\sin \omega t}{1 - (r/2l)^2 (1 - \cos 2\omega t)}$$

$$s \approx r \cos \omega t + \left[1 - \left(\frac{r}{2l}\right)^2 (1 - \cos 2\omega t)\right]$$

By graphically plotting τ versus ωt, the constant (or average) component and oscillating component, τ_c and τ_o, of the torque can be rather closely approximated.

With information on the engine-supporting mass which in turn is resiliently mounted, and the location of the center of gravity, all of the impressed torques on the system can be determined by using the technique applied in Equations 1.1 through 1.6 in *Example* 1.



$$R^2 = r_1 r_2 r_3 \frac{r_1 \sin \phi_1 + r_2 \sin \phi_2 + r_3 \sin \phi_3}{r_2 r_3 \sin \phi_1 + r_1 r_3 \sin \phi_2 + r_1 r_2 \sin \phi_3} \quad (2)$$

Another method is to suspend the machine like a pendulum, *Fig.* 2, and use

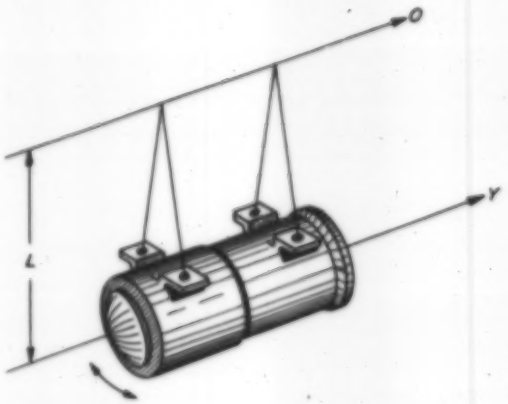
$$I_0 = \frac{WL}{4\pi^2 f_o^2} \quad (3)$$

and

$$I_y = I_0 - \frac{WL^2}{g} \quad (4)$$

using either pair of equations, an accurate value will be achieved if the length of wires is selected so that the frequency of oscillation f_o about the indicated axis can be precisely determined. A small angular displacement should be used.

Fig. 2—Pendulum method for determining moment of inertia about the *Y* axis



Products of Inertia and Principal Axes: Establishing the products of inertia, I_{xy}, I_{xz} and I_{yz}, is much more complicated than finding the polar moments of inertia. The products can be determined experimentally in a dynamic balancing machine, if the machine to be isolated is small enough to fit in the balancer. At best, this is a very difficult task. However, the products of inertia are zero if the three (mutually perpendicular) principal axes are selected as the reference axes. By definition, one principal axis has the maximum polar moment of inertia, while one of the other two has the minimum. It is easier to determine the principal axes (by experimentally finding the maximum and minimum polar moments) than it is to determine the products of inertia for any other set of reference axes. For rather simple structures, such as the motor-generator set of *Example* 1, the principal axes coincide with the geometric axes. However, complex machines, such as the 90-degree V-8 automobile engine illustrated in *Example* 3, necessitate experimental methods of finding the principal axes.

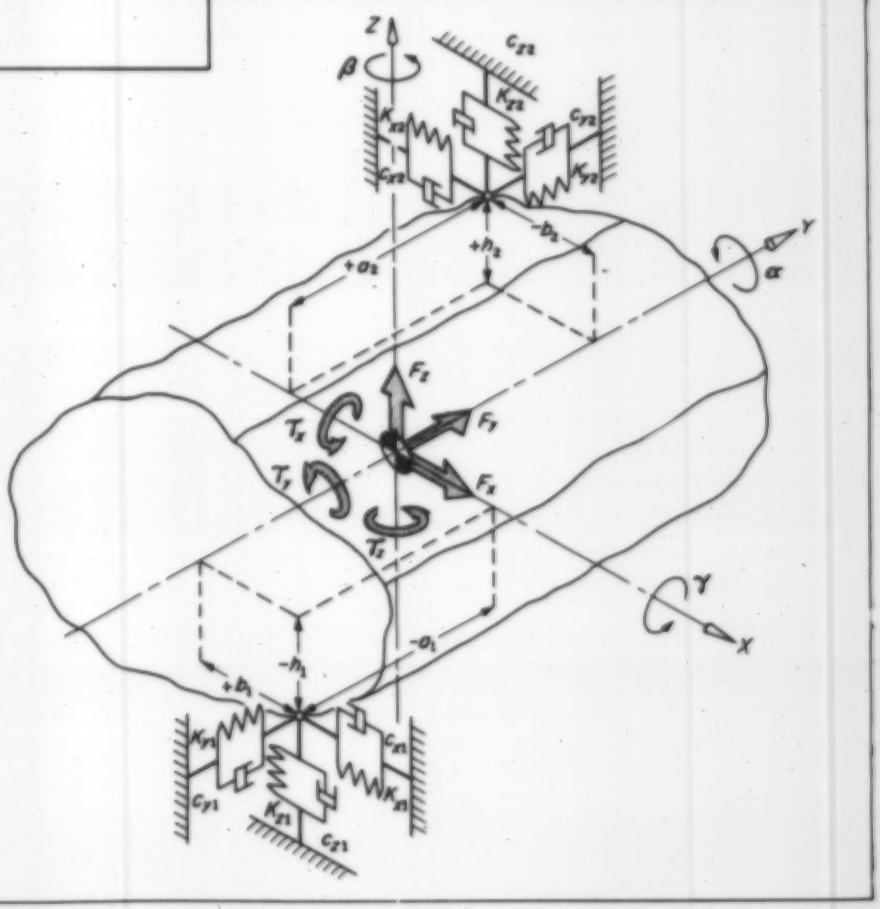


Fig. 3 — Generalized diagrammatic model of a vibrating system. Shown are impressed forces and torques, *F* and *τ*, and locations *(a, b, h)*, spring rates *(K)* and damping coefficients *(c)* of the mountings

STEP 3— Establishing Mount Characteristics

Although it is usually impossible or impractical to change materially the impressed forces and torques or the machine characteristics, resilient mount properties and their locations in relation to the machine can be varied widely to provide the desired vibration isolation.

Mount properties important to the analysis are the dynamic spring rates K (force per unit deflection) and the viscous damping ratios c/c_c (no dimensional units) in the three (mutually perpendicular) principal directions of the resilient member. The particular shape of the selected isolator and its material are pertinent only in the respect that the desired spring rates and damping coefficients are obtained and maintained.

When mounts are purchased commercially, dynamic (rather than static) spring rates and damp-

Example 3—Deriving Equations of Motion: V-8 Engine

As an example of how the general Equations 5 through 7a can be reduced to simpler forms, a 90-degree V-8 automobile engine will be considered. To avoid determining the products of inertia, the principal axes will be used as the reference axes. As found experimentally, two of these axes, Y and Z, are inclined approximately 15 degrees from the normally horizontal and vertical directions, while the X axis is unchanged. This engine can be substantially balanced in all modes as far as the reciprocating parts and rotating members are concerned.[8] However, there is no common way of eliminating the oscillating component τ_o of the load-delivering torque. The frequency of torque oscillation, Ω, is the so-called "firing frequency" of the engine—the number of power strokes per second. For a four-stroke cycle eight-cylinder engine, the frequency is equal to four times the shaft speed.[8]

Assume that the vibration mounts are located in the common orientation shown: $a_1 = a_2$, $b_1 = -b_2$, $b_3 = 0$, $h_1 = h_2$. If the mounts are selected so that

$$K_1 = K_2 = \frac{1}{2} K_3 \frac{-a_3}{a_1}$$

for K_x K_y, and K_z of each mount, each of the following terms in Equations 5 through 7a will be equal to zero: $\Sigma K_x a$, $\Sigma K_y b$, $\Sigma K_z a$, $\Sigma K_z b$, $\Sigma K_y b h$, $\Sigma K_z a b$. Impressed forces and torques on the system are

$$\tau_h = \tau_o \sin \Omega t$$

$$\tau_y = \tau_h \cos 15°$$

$$\tau_z = \tau_h \sin 15°$$

and F_x, F_y, F_z, and τ_x each equal to zero.

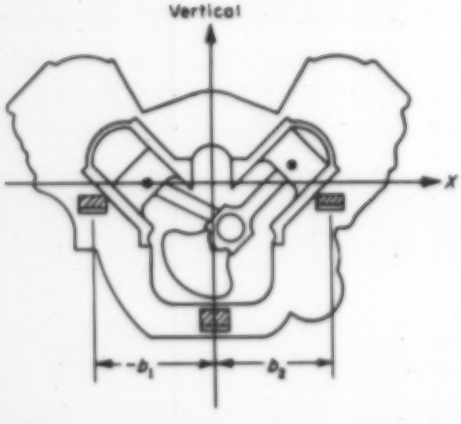
Making these substitutions in Equations 5 through 7a, only the following equations must be considered

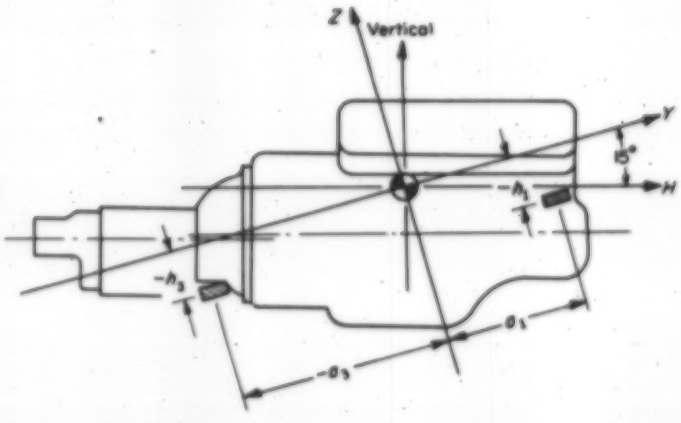
$$(mD^2 + \Sigma K_x)x - (\Sigma K_x h)\alpha = 0 \quad \ldots\ldots (3.1)$$

$$(I_y D^2 + \Sigma K_x h^2 + \Sigma K_z b^2)\alpha - (\Sigma K_x h)x + (\Sigma K_x a h)\beta = \tau_o \cos 15° \sin \Omega t \quad \ldots\ldots (3.2)$$

$$(I_z D^2 + \Sigma K_z a^2 + \Sigma K_y b^2)\beta + (\Sigma K_x a h)\alpha = \tau_o \sin 15° \sin \Omega t \quad \ldots\ldots (3.3)$$

Vibrations will die out in the x mode and the y and γ coupled mode with only a slight amount of damping in the isolators, because no oscillating excitation is being applied to sustain them. As forced vibrations take place in only three directions (x, α, β) instead of six, the analysis is much simpler. It involves the simultaneous solution of Equations 3.1, 3.2 and 3.3. However, even the analysis of these modes of vibration involves a considerable amount of computation.





ing ratios should be requested from the manufacturer. However, some manufacturers have not determined these characteristics, thus forcing the designer to conduct his own vibration tests or to obtain assistance elsewhere. Although this situation may seem quite unsatisfactory, in many cases the cost of vibration tests is considerably less than the possible expense of correcting a faulty machinery installation.

STEP 4— Setting Up a Diagrammatic Model

By consideration of impressed forces and torques, and the machine and mount characteristics, a diagrammatic model of the machine's vibrating system can be set up. A generalized model is illustrated in *Fig.* 3. The formulation of this model is an important step in a vibration analysis, since the equations of motion which describe the vibrational behavior of the machine are derived from it.

From *Fig.* 3, it is seen that three mutually perpendicular reference axes are set up through the center of gravity. All six possible modes of vibration, three translational and three rotational, are considered. However, the diagrammatic model is based on a very important assumption, that of a rigid mass on massless linear isolators. For this assumption to be valid, certain limitations apply to the vibrating system:

1. Frequency of the impressed forces and torques must be low enough for the machine frame to act as a rigid mass and the mounts to act as simply deflected units. For very high frequency vibrations, there is wave motion between "particles" of both the machine frame and the mounts. This oscillation must be described by acoustical theory rather than by the vibration analysis discussed here. Although each machinery installation must be considered individually, impressed frequencies below 500 cps can usually be considered in the vibration range.
2. The machine and its foundation must be substantially rigid in construction. Again, flexibility allows wave motion, which will not be considered in this analysis.
3. Dynamic characteristics of the resilient mounts must be nearly constant and independent of vibrational amplitude and frequency. Their mass must be small in comparison with that of the machine.

In addition, small oscillatory motions of the machine are assumed. In the great majority of machinery installations, all these conditions are met reasonably well.

In *Fig.* 3, the resilient mounts are oriented so that their principal directions are parallel to the reference axes of the machine. Since the problem of inclined isolators adds materially to the complexity of the mathematical analysis, only parallel-directed elements are considered here.

STEP 5— Deriving Equations of Motion

Construction of the diagrammatic model simplifies the mathematical analysis. This analysis consists of considering all the forces and torques on the machine frame, and applying them in Newton's equations of motion:

summation of forces = mass × linear acceleration
summation of torques = inertia × angular acceleration

for each of the three translational and three rotational modes of vibration. The forces and torques fall into two general categories:

1. Those applied by the impressed forces and torques.
2. Those developed by the resilient members while resisting or assisting the motion of the machine frame.

Derivation of the equations of motion of a body vibrating in six modes has been presented elsewhere for principal axes.[7] However, these general equations can be found for any set of reference axes by adding the product of inertia terms. For forces in the X direction and torques about the X axis:

$$F_x = (mD^2 + \Sigma K_x)x - (\Sigma K_x h)a - (\Sigma K_x a) \quad (5)$$

and

$$\tau_x = (I_x D^2 + \Sigma K_y h^2 + \Sigma K_z a^2)\gamma - (\Sigma K_y h)y + (\Sigma K_z a)z - (I_{xz} D^2 + \Sigma K_y bh)\beta - (I_{xy} D^2 - \Sigma K_z ab)\alpha \quad (5a)$$

To include damping, the damping factor is added to the spring rate factor; e.g., Equation 5 becomes

$$F_x = (mD^2 + \Sigma c_x D + \Sigma K_x)x - (\Sigma c_x hD + \Sigma K_x h)a - (\Sigma c_x aD + \Sigma K_x a)\beta$$

For a complete analysis, the forces and torques in the Y and Z directions are:

$$F_y = (mD^2 + \Sigma K_y)y - (\Sigma K_y h)\gamma + (\Sigma K_y b)\beta \quad (6)$$

$$\tau_y = (I_y D^2 + \Sigma K_x h^2 + \Sigma K_z b^2)\alpha - (\Sigma K_x h)x + (\Sigma K_z b)z - (I_{yz} D^2 - \Sigma K_x ah)\beta - (I_{xy} D^2 - \Sigma K_z ab)\gamma \quad (6a)$$

$$F_z = (mD^2 + \Sigma K_z)z + (\Sigma K_z b)\alpha + (K_z a)\gamma \quad (7)$$

$$\tau_z = (I_z D^2 + \Sigma K_x a^2 + \Sigma K_y b^2)\beta - (\Sigma K_x a)x + (\Sigma K_y b)y - (I_{yz} D^2 - \Sigma K_x ah)\alpha - (I_{xz} D^2 + \Sigma K_y bh)\gamma \quad (7a)$$

These four general equations are to be added to Equations 5 and 5a.

Taken together, Equations 5 through 7a form a system of six simultaneous differential equations. Their solution is a very arduous task. If mount and machine characteristics have been determined, a general solution is possible by using an analog computer. Without the advantages of a computer, a general solution is usually impractical to obtain. A computer cannot be used if the isolator

Example 4—Determining Transmissibilities:

TRANSMISSIBILITIES can be determined for more than a single mode of vibration, but their derivation is complex. For example, a set of four undamped equal springs can be installed under the motor-generator set shown in sketch *a* to isolate the foundation from the centrifugal force, F_c. Let them form a base under the machine, symmetrical about the center of gravity. Using the principal axes shown as the reference axes, the following terms from the general equations of motion, Equations 5 through 7*a*, are zero: $\Sigma K_x a$, $\Sigma K_y b$, $\Sigma K_z a$, $\Sigma K_z b$, $\Sigma K_x a h$, $\Sigma K_y b h$, $\Sigma K_z a b$, I_{xy}, I_{xz}, and I_{yz}. In sketch *a* and Equations 1.4 through 1.6 (*Example* 1), consider x_r, y_r, and z_r equal to zero. Then by substitution in Equations 5 through 7*a*,

$$(mD^2 + \Sigma K_x)x - (\Sigma K_x h)a = F_c \cos \omega t \quad (4.1)$$

$$(I_y D^2 + \Sigma K_x h^2 + \Sigma K_z b^2)a - (\Sigma K_x h)x = 0 \quad (4.2)$$

$$(m D^2 + \Sigma K_z)z = F_c \sin \omega t \quad (4.3)$$

The other three equations can be neglected because no excitation is applied. In other words, rotational oscillations about the vertical axis (β mode) and rocking vibrations about the horizontal axis (y and γ coupled mode) will die out with a slight amount of damping in the mounts.

It is seen from Equation 4.3 that the vertical (z mode) vibration is independent of the other modes, and therefore its vibration characteristics can be described by the single degree of freedom system outlined in text. In this case, $F_c = F_o$, $\Sigma K_z = K$, and $\omega_z = \omega_n$.

The x and α coupled rocking mode has the force F_c sustaining the vibration, which must be considered. From Equations 4.1 and 4.2,

$$a_1 x - a_2 a = F_c \cos \omega t \quad (4.4)$$

and

$$a_2 a - a_3 x = 0 \quad (4.5)$$

where

$$a_1 = m D^2 + \Sigma K_x$$

$$a_2 = I_y D^2 + \Sigma K_x h^2 + \Sigma K_z b^2$$

$$a_3 = \Sigma K_x h$$

Equations 4.4 and 4.5 can be solved simultaneously to obtain x (the instantaneous horizontal displacement of the center of gravity), and α (the instantaneous rotational motion of the body about the Y axis). Solving for x,

$$(a_1 a_2 - a_2^2)\, x = a_2 F_c \cos \omega t \quad (4.6)$$

Making the assumption that [11]

$$x = A \sin \omega t + B \cos \omega t \quad (4.7)$$

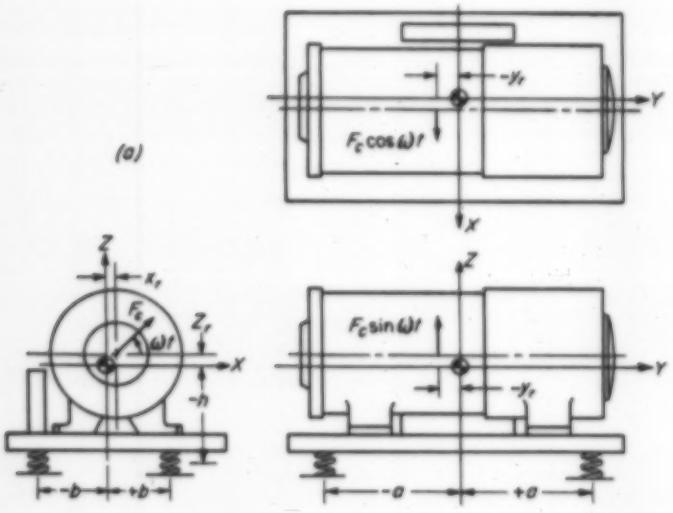
and substituting in Equation 4.6, then $A = 0$, and

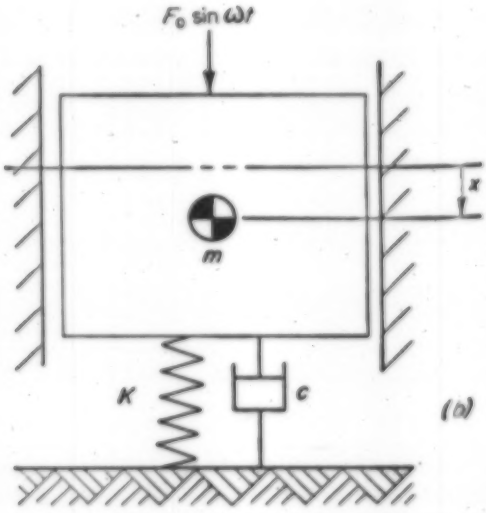
$$B = F_c (\Sigma K_x h^2 + \Sigma K_z b^2 - m R_y^2 \omega^2) / [m^2 R_y^2 \omega^4 - (\Sigma K_x h^2 + \Sigma K_z b^2 + R_y^2 \Sigma K_x)\, m \omega^2 + \Sigma K_x (\Sigma K_z b^2)]$$

Since $x_o = (A^2 + B^2)^{1/2}$, (Reference 11) upon suitable substitution the amplitude factor in x can be derived:

$$A_x = \frac{x_o}{\left(\frac{F_c}{\Sigma K_x}\right)} = \left\{ \frac{\Sigma K_z}{\Sigma K_x} \left[\frac{\Sigma K_x}{\Sigma K_z} \left(\frac{h}{r}\right)^2 + \left(\frac{b}{r}\right)^2 - \left(\frac{\omega}{\omega_z}\right)^2 \right] \right\} \Big/ \left\{ \left(\frac{\omega}{\omega_x}\right)^4 - \left[\frac{\Sigma K_x}{\Sigma K_z} + \frac{\Sigma K_x}{\Sigma K_z} \left(\frac{h}{r}\right)^2 + \left(\frac{b}{r}\right)^2 \right] \left[\frac{\omega}{\omega_z}\right]^2 + \frac{\Sigma K_x}{\Sigma K_z} \left(\frac{b}{r}\right)^2 \right\} \quad (4.8)$$

Similarly, Equations 4.4 and 4.5 can be solved





Motor-Generator Set

for a, resulting in the following amplitude factor:

$$A_a = \frac{a_0}{\left(\frac{F_c}{\Sigma K_x}\,\frac{1}{R_y}\right)} = \left(\frac{\Sigma K_x}{\Sigma K_z}\right)^2\left(\frac{h}{r}\right)\Big/ \left\{\left(\frac{\omega}{\omega_z}\right)^4 - \left[\frac{\Sigma K_x}{\Sigma K_z} + \frac{\Sigma K_x}{\Sigma K_z}\left(\frac{h}{r}\right)^2 + \left(\frac{b}{r}\right)^2\right]\left[\frac{\omega}{\omega_z}\right]^2 + \frac{\Sigma K_x}{\Sigma K_z}\left(\frac{b}{r}\right)^2\right\} \quad (4.9)$$

Equations 4.8 and 4.9 show the dependence of the amplitude factors A_z and A_a on spring rates (ΣK_x, ΣK_z), on location of mounts h and b, on radius of gyration R_y, on vertical natural frequency ω_z, and on impressed frequency ω.

The force transmitted horizontally through the mounts F_{tx} is

$$F_{tx} = \Sigma K_x\,(z - ha)_a$$

Thus, for this example, the horizontal transmissibility T_x can be given as

$$T_x = \frac{F_{tx}}{F_c} = A_z - \frac{h}{r}A_a \quad (4.10)$$

In the unit, an oscillating moment M_{ta} is transmitted vertically through the mounts; when the machine "rocks" to the left, the left spring is compressed vertically and the right one is extended. Although this rocking moment is superimposed on the vertical (z-mode) vibration, it can be considered independently of it. Therefore, the oscillating moment is

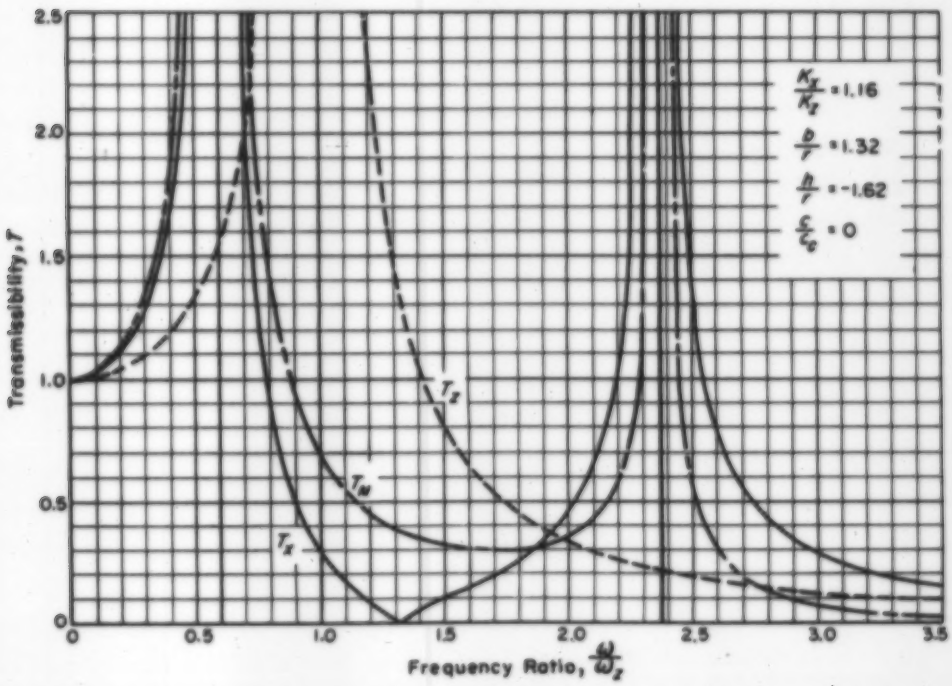
$$M_{ta} = \Sigma K_z\,b^2\,a_a$$

The moment transmissibility T_m is defined as

$$T_m = \frac{M_{ta}}{F_c h} = \frac{\left(\frac{b}{r}\right)^2}{\frac{\Sigma K_x}{\Sigma K_z}\,\frac{h}{r}}A_a \quad (4.11)$$

Thus both horizontal and moment transmissibilities can be found for the motor-generator set of sketch a (except when $h = 0$). The vertical transmissibility T_z, given for a single degree of freedom system in sketch b, when added to these transmissibilities, will determine the vibration performance of the motor-generator set in both rocking and vertical modes. When the isolators have already been selected, then appropriate values of mount properties and locations and machine characteristics can be substituted into Equations 8, 4.10 and 4.11 to determine the transmissibilities and the transmitted vibrational forces F_{tz}, F_{tx} and moment M_{ta}.

When the resilient mounts are to be selected to give the proper vibration attenuation, all transmissibilities must be small. In general, optimum isolation is achieved when the summation of all transmissibilities is a minimum. For example, consider the motor-generator set as having the following characteristics: $R_y = 9.1$ inches; $x_r = y_r = z_r = 0$; $W = 3750$ lb; and



(c)

Example 3 (cont.)— Determining Transmissibilities

ω = 1800 rpm, a constant. Let the set of springs be located at $h = -14.75$ inches and $b = \pm 12.0$ inches.

For these springs a wide variety of sizes is available. However, all sizes have one thing in common; the ratio of horizontal to vertical spring rate for each isolator is approximately 1.16, a constant value. Therefore $\Sigma K_x/\Sigma K_z = 1.16$; $h/r = -1.62$; and $b/r = \pm 1.32$.

Substituting these values into Equations 4.8 and 4.9 for use in Equations 4.10 and 4.11, horizontal and moment transmissibilities T_x and T_m are found as a function of frequency ratio ω/ω_z. In addition, the vertical transmissibility T_z must be considered. Graph *c* shows the three transmissibility curves obtained.[12]

If the spring sizes are selected so that the ratio of impressed frequency to vertical natural frequency lies in the ranges $1.6 < (\omega/\omega_z) < 2.1$ or $(\omega/\omega_z) > 2.6$, isolation is achieved both horizontally and vertically. A faulty installation, however, would result if $0 < (\omega/\omega_z) < 1.6$ or $2.1 < (\omega/\omega_z) < 2.6$ because of resonance in these ranges.

Very good vibration control is achieved when $\omega/\omega_z = 1.90$ since at this frequency ratio the transmissibilities are $T_z = 0.38$, $T_x = 0.34$, and $T_m = 0.32$.

Springs will now be selected to obtain these results. From the machine characteristics above, the mass and impressed frequency are $m = W/g = 3750/386 = 9.72$ lb-second^2/in. and $\omega = 2\pi\ (1800)/60 = 188.5$ radians/second. Therefore, the desired vertical natural frequency and spring rates are $\omega_z = 188.5/1.90 = 99.4$ radians/second; and $\Sigma K_z = m\ \omega_z^2 = 9.72\ (99.4)^2 = 96{,}000$ lb/in.

Since there are four springs, the vertical spring rate for each isolator is 96,000/4 = 24,000 lb/in. The horizontal spring is 1.16 (24,000) = 28,000 lb/in. With this selection of mount spring rates, good isolation from centrifugal force is assured.

Other important information can be found from graph *c*. For example, if the motor-generator set were not a constant-speed machine, increasing or decreasing the speed from 1800 rpm would produce much higher transmissibilities on the average. In this case, it would be better to use softer springs than those selected above, so that the lowest impressed frequency is higher than the highest resonance, i.e., $(\omega/\omega_z) > 2.6$. Although good vibration control would then be achieved, lack of stability might be a problem due to the low spring rates.

Another principle demonstrated is the risk taken when isolators are selected on the basis of vertical transmissibility only. Unpredicted horizontal and moment resonance in the higher frequency range might easily occur if the rocking vibration transmission were left to chance. characteristics are to be selected on the basis of this analysis.

However, a general solution is not necessary in the great majority of problems. For most cases, not more than two or three modes of vibration are excited sufficiently and thus need to be considered. Reasons are:

1. Impressed forces or torques usually act in only one or two directions.
2. Mounts are usually located in some common symmetrical manner, so that (1) the summation of each mount's spring rate times its respective distance from the center of gravity equals zero, and (2) a similar summation of damping coefficients times distances to center of gravity equals zero.

Thus the general equations of motion can usually be reduced to much simpler equations.

To illustrate, *Example* 3 shows an analysis and reduction for a V-8 engine.

Center of Gravity Suspension: If the mounts in *Example* 3 were placed in the *XY* principal plane, a center-of-gravity mounting system would be obtained. In Equations 5 through 7*a*, the following factors in addition to those of *Example* 3 would be zero:

$$\Sigma K_x h,\ \Sigma K_y h,\ \Sigma K_x a h,\ \Sigma K_x h^2,\ \Sigma K_y h^2$$

The vibrational modes would then be completely independent of each other. Although a center-of-gravity suspension allows independent consideration of each of the six modes, better vibration control is not necessarily assured by its use. Other pertinent factors, previously mentioned, are still equally important.

STEP 6— Determining Transmissibilities

Isolators are generally selected so that the oscillating forces and torques transmitted through them to the base, foundation or supporting members are significantly less than the impressed forces and torques on the machine. A ratio containing these quantities is the transmissibility, which is defined as the ratio of the transmitted force or torque to the impressed force or torque. Transmissibility is the widely accepted criterion for vibration isolation.

For a single degree of freedom system (*Example* 4, sketch *b*), the damped transmissibility T can be most easily determined by utilizing

$$T = \frac{F_t}{F_o} = \sqrt{\frac{1 + \left(2\frac{c}{c_c}\frac{\omega}{\omega_n}\right)^2}{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(2\frac{c}{c_c}\frac{\omega}{\omega_n}\right)^2}} \quad (8)$$

where

$$F_t = \sqrt{\left(c\,\frac{dx}{dt}\right)^2 + (Kx)^2}$$

Isolation is achieved when the transmissibility is less than unity, since the transmitted force F_t is less than the impressed force F_o, while undesired resonance occurs when transmissibility is a maximum. The best isolation is obtained when the transmissibility can be made as small as possible. As seen from Equation 8, the transmissibility depends on the impressed frequency ω, the undamped natural frequency ω_n, and the amount of damping c/c_c. These factors are discussed elsewhere in more detail.[9, 10]

When the mounts are to be selected from the analysis, their dynamic spring rates and damping ratios should be chosen to effect a low transmissibility. For the single degree of freedom system, a low transmissibility is produced when the spring rate K is small enough to obtain a natural frequency ω_n much lower than the impressed frequency ω. This can be seen from the T_c-curve in *Example* 4, chart *c*.

When the isolators have already been chosen for a single degree of freedom system, their characteristics can be substituted into Equation 8 and succeeding equation to determine what transmissibility T and transmitted force F_t have been achieved, which is the objective of this analysis.

Actual determination of transmissibilities and a general method of isolator selection are given in *Example* 4.

Conclusion: By following the procedure outlined in the previous sections, a vibration analysis can be performed on any machine that satisfies the limitations set on the system. Fortunately, this includes most machinery vibration problems. The step-by-step method considers all the pertinent factors for selecting isolators or determining the magnitudes of transmitted vibrations. The risk of a faulty vibration control system can be substantially reduced by leaving no factors to guesswork or chance.

Often, it is common practice not to perform a thorough analysis. In many cases an analysis is not necessary because the isolators are installed on a trial and error basis until good vibration attenuation is obtained. Many times, however, the desired isolation is not achieved, or the cost of this method is found to be substantially greater than the cost of performing the analysis. In cases where mounts cannot be selected on a cut-and-try basis, since post-installation remedial measures are expensive or impossible, a vibration analysis must be considered an essential part of the machine design. Furthermore, the analysis can indicate what values are needed for optimum isolation and how much vibration transmission can be expected.

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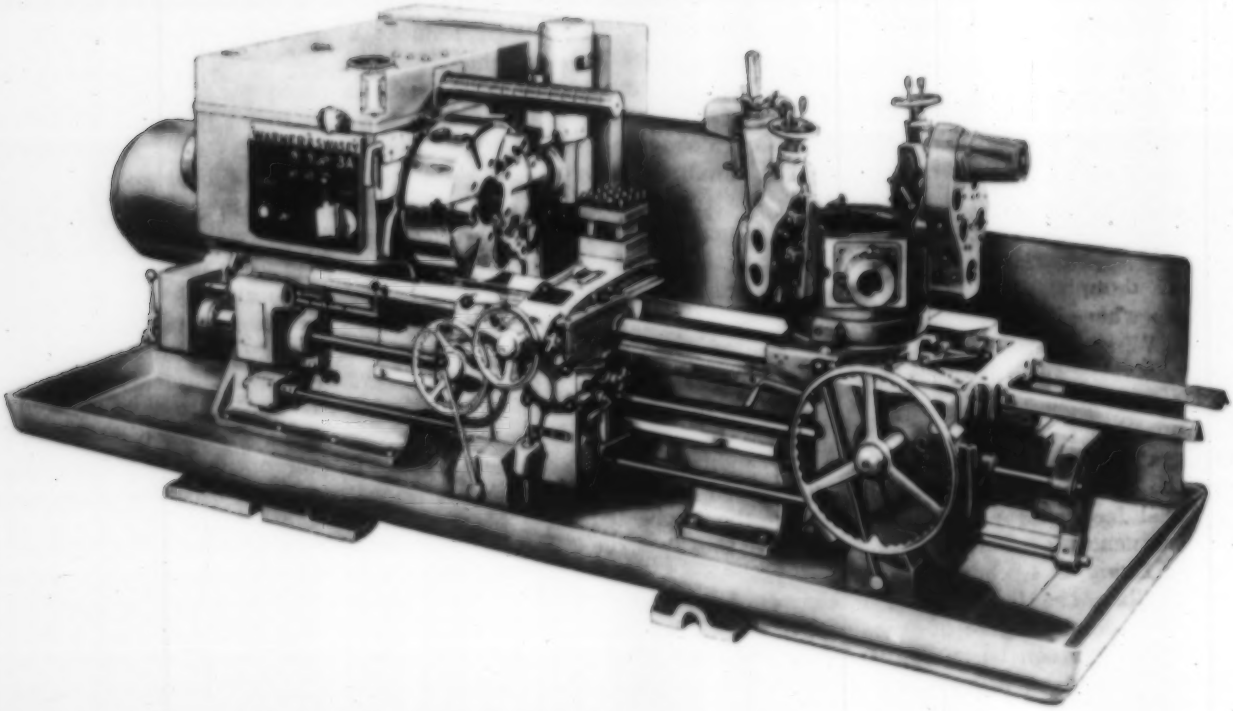
They Say . . .

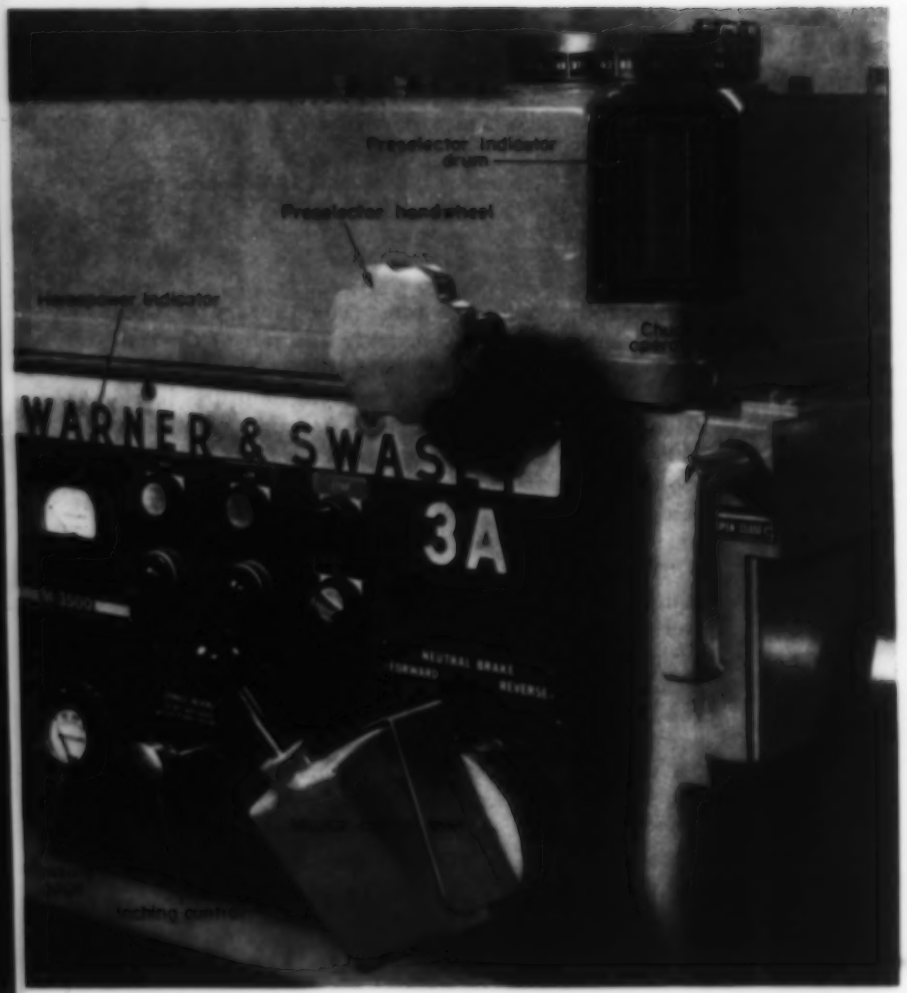
"The progress of our civilization in peace time depends, and has always depended, not only on our current thoughts and findings, but on the skill and facility with which we create, store, interchange, consult, and utilize the whole record of our collective past experiences. We are making enormous strides in the development of methods for creating a record of what we learn—in printed words, by photography, or on a magnetic tape. We are also making strides in developing means for the transmission of ideas from one to another or from a central point to great audiences. But in one exceedingly important phase of the whole problem we are making little progress indeed. This is the phase of finding in the record the information that we need. If the record of our experience is to serve us well, we need to be able to extract from it at will, promptly and inexpensively, any single item of current moment.

"We are building the record at a prodigious rate. Books, magazines, technical journals, reports are being produced by the ton. The Library of Congress reported in its *Quarterly Journal of Current Acquisitions* for August, 1954 that in fields of science, technology, medicine and agriculture it received approximately 30,000 journals including 2000 new titles; 25,000 research reports; 15,000 books and monographs; 15,000 manuscripts; 10,000 pamphlets; 5000 prints, blueprints, microfilms, etc.; and 150,000 maps and charts.

"Our libraries are filled to overflowing, and their growth is exponential. Yet in this vast and ever-increasing store of information we still hunt for particular items by horse and buggy methods. As a result there is much duplication and repetition of research. We are being smothered in our own product. While we record with great care the work of thousands of able and devoted men, full of significance and timeliness to others, a large and increasing fraction of their work is, for all essential purposes, lost simply because we do not know how to find a pertinent item of information after it has become embedded in the mass."
—VANNEVAR BUSH, *president, Carnegie Institution of Washington*.

Turret Lathe Incorporates Automatic

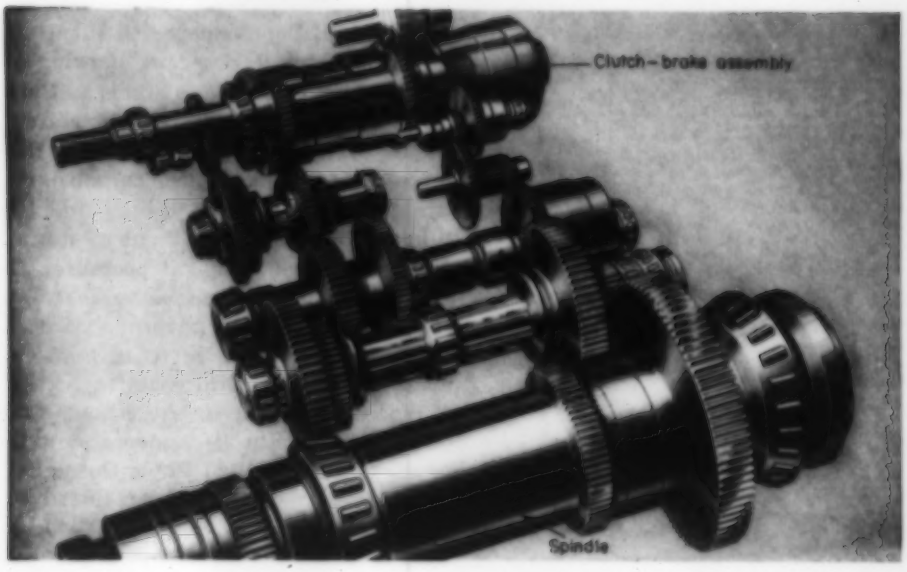


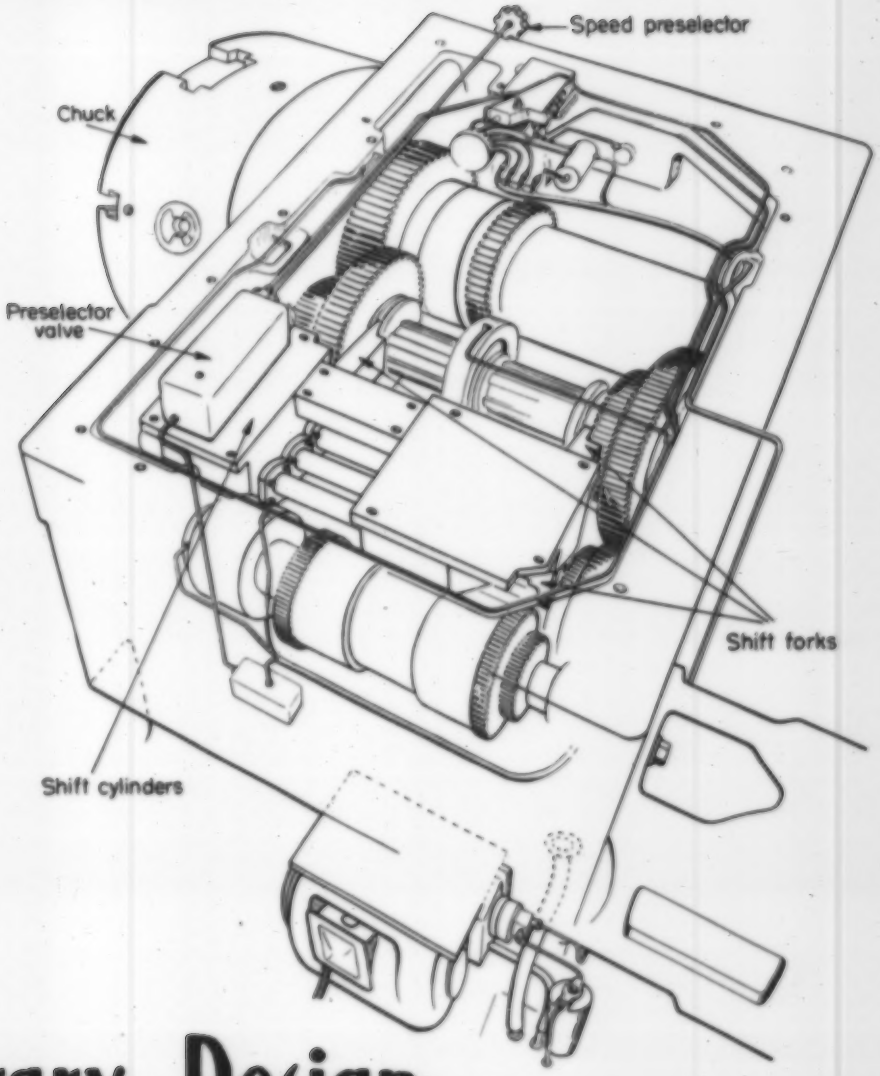


MANY features planned to make operation easier have been incorporated in a recently introduced series of extra heavy-duty turret lathes. Any one of 16 spindle speeds may be preselected while a cut is in progress. The shift is performed hydraulically after the cut is completed when the operator pushes the master control handle. Made in four different sizes by Warner & Swasey Co., these lathes have maximum bed swings ranging from 18 to 29½ in. Bar stock capacities range from 2½ to 12 in. diameter rounds. Spindle motors may have from 15 to 75 hp.

Headstock controls are conveniently grouped and plainly marked. The master control lever starts, stops and reverses spindle rotation as well as initiating the preselected gear shifts. Other controls are for preselection of desired spindle speeds, spindle inching, chuck wrench operation and starting and stopping the spindle drive motor.

Gear Shifting, Chucking

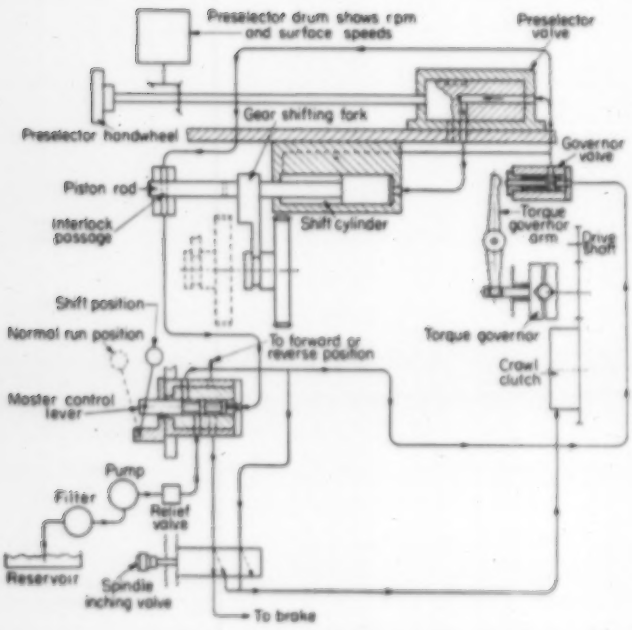




Hydraulic gear Shifting to engage the appropriate gears in the headstock is performed by four hydraulic cylinders. These cylinders move sliding gears on splined shafts to select the proper gear ratio from the 16 available. The preselector valve selects the proper cylinder or cylinders to perform the desired shift.

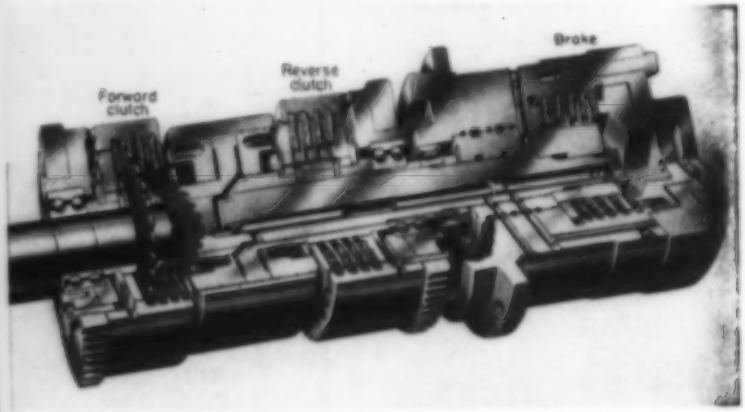
Contemporary Design

Contemporary Design

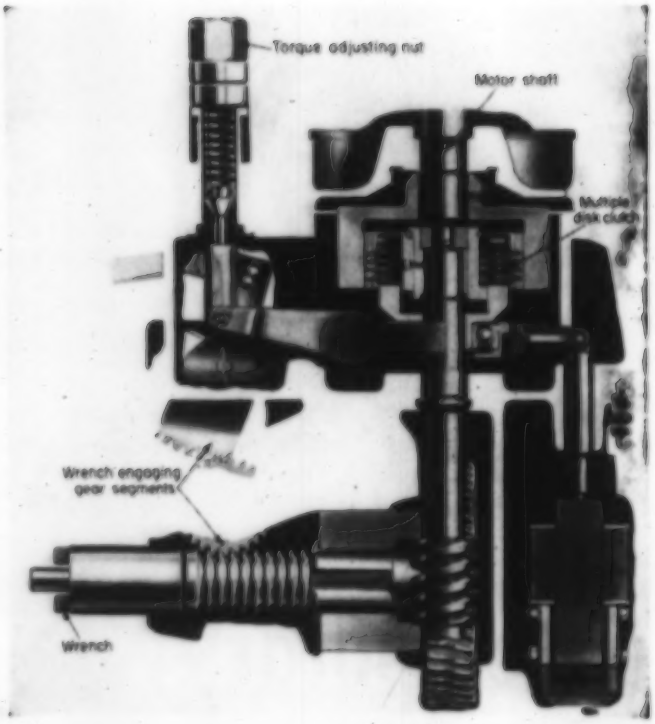


Gear shifting sequence is illustrated by a simplified circuit diagram showing only one of the four hydraulic cylinders. Pushing the master control lever to the shift position moves a valve plunger to energize the "shift" circuit and disconnect the forward, reverse or brake clutch. Once pushed in, the valve plunger cannot be pulled out to stop the shift. Plunger return is by oil pressure. Oil flows from the master control valve to both the crawl clutch and the governor valve. Purpose of the crawl clutch is to turn the gears at slow speed to facilitate shifting.

When crawl speed is reached, the torque governor permits the governor valve spool to move and oil then flows through the preselector valve to the proper shift cylinder or cylinders. At the end of the shift, oil flows from the cylinder through pistonrod interlock passages which then line up. From the interlock passages, flow is to the end of the master valve spool. Pressure then returns the master valve spool to its normal running position. Movement of the master valve spool redirects pump output to either the forward or reverse clutch and operation is resumed. This sequence of events requires approximately five seconds at medium speeds. At high speeds with high inertia loads shift times are slightly longer.



The power chuck wrench uses a small electric motor to both tighten and loosen the chuck. Movement of the control handle engages the wrench jaws with the chuck through gear segments. An adjusting nut controls the torque transmitted by the multiple-disk clutch to provide the correct gripping force for heavy or delicate work. A solenoid is used to fully compress the clutch plates and allow full motor torque to be used for unchucking regardless of the torque adjustment. The selector switch on the control panel makes the chuck wrench usable in this manner for both external and internal chucking. Interlocks prevent accidental engagement of the wrench while the spindle is rotating or starting of the spindle while the wrench is engaged.



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Points to consider in selecting Push-Pull Solenoids

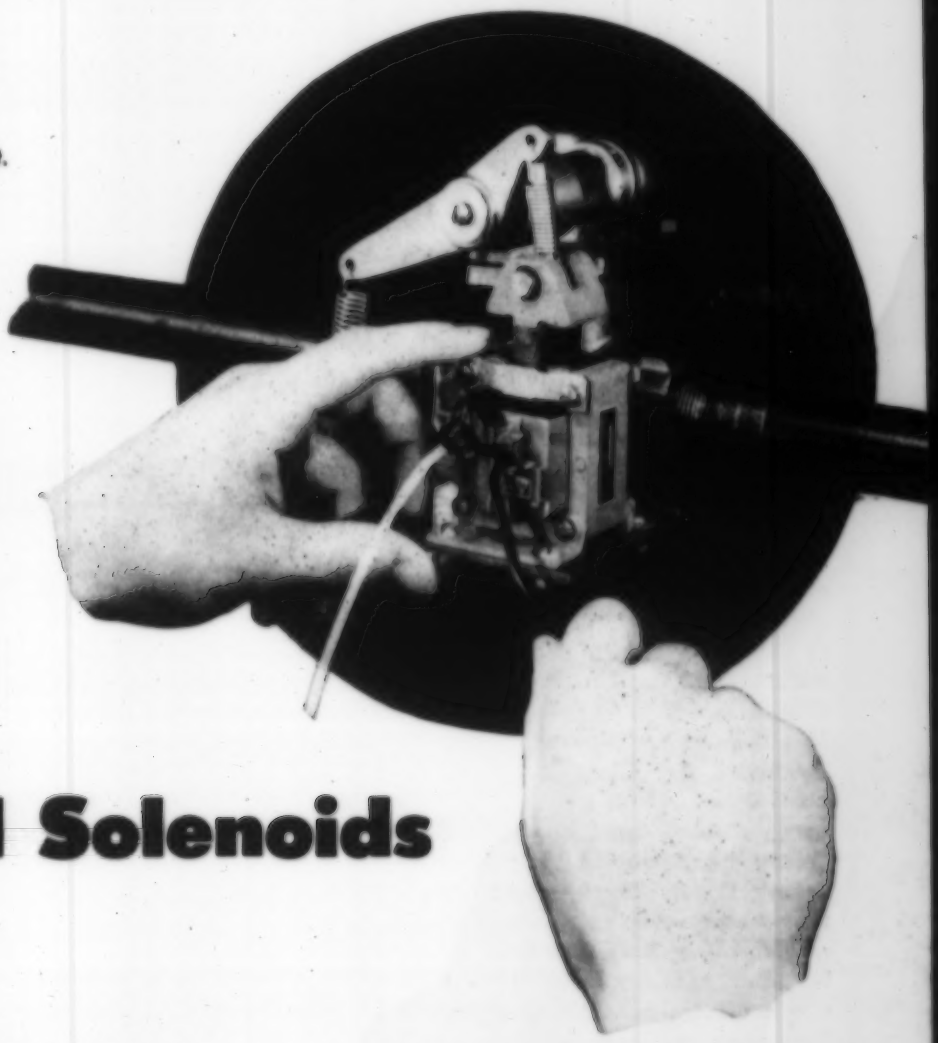
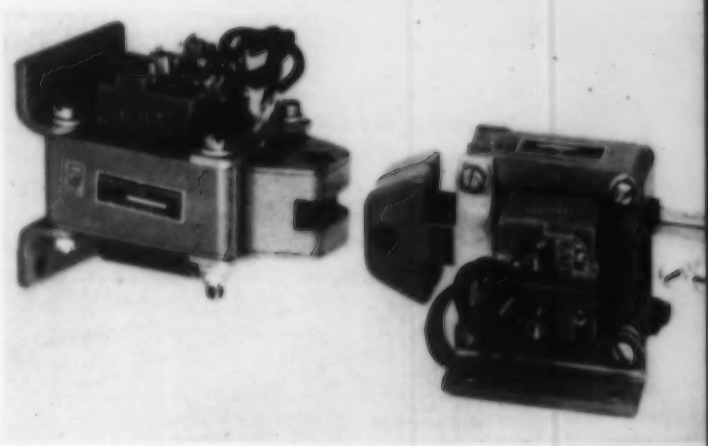


Fig. 1—Above—This industrial solenoid operates a Ruggles Klingman valve through a mechanical linkage

Fig. 2—Below—Industrial solenoids of the push type, left, and the pull type, right, are commonly available



REMOTELY controlled mechanical movement encountered in many automatic operations can often be obtained with an electromagnetic actuator, or solenoid, *Fig.* 1. In choosing such a device for a specific application, the designer is often faced with a choice between designing a special solenoid or magnet for his intended application, and specifying a suitable standard or modified standard solenoid.

Use of standard solenoids is advantageous in terms of cost and renewal parts, although proper selection and application may be a little more difficult. Careful analysis of the design requirements of the intended application will facilitate a choice from available standard types.

Mechanical Requirements: The requirements of the mechanism to be operated by the solenoid should be carefully analyzed. This analysis will determine whether optimum use of the available space can be achieved by use of the pull or push-type solenoids, *Fig.* 2. There are two types of push solenoids: One delivers its thrust through a member which is an integral part of the plunger, and the other through a loose pin. With both types, consideration should be given to the manner of returning the plunger to its initial position. This is important since the standard solenoid is unidirectional insofar as electrical operation is concerned.

The push-type solenoid can be employed to deliver a hammer blow. The plunger travels free, opposed only by a light return spring before it strikes a pin which actuates the mechanism. This action is useful for starting high inertia loads or "cracking" valves against high pressure. However,

it shortens the mechanical life of a solenoid, particularly the laminated type.

Great care should be taken to insure correct alignment of the solenoid plunger with the operating mechanism. If necessary, a linkage should be provided to minimize side thrust on the plunger. Although most solenoids are equipped with brass, stainless steel or glass-filled polyester plunger guides, the combination of sliding wear and lateral impact will cause trouble if the plunger is not allowed to center itself.

The method of coupling the solenoid to the mechanism should be checked to permit the plunger to seat fully. Coil current of an ac solenoid decreases rapidly as the plunger seats, *Fig.* 3. If free seating is not permitted, coil heating will result due to high current. Excessive noise will result because of loss of pole-shading effect.

Standard dc solenoids employ interlocks called cut-out switches. Here coupling is particularly important since the cutout operates in approximately the last 3/32-inch of plunger travel to introduce resistance in the circuit. The effect of this operation is shown in *Fig.* 4. If it does not occur due to failure of the solenoid to close, the coil quickly overheats. Dc solenoids specifically designed for use without cutout switches can, however, be held open without damage.

Solenoid mounting may be made resilient to absorb shock. In the event rubber is used, the temperature rise of the coil should be checked to insure that heat flow from the solenoid has not been impeded. Otherwise there is a possibility that a serious rise in coil temperature will result.

Load Requirements: After determining the type of operation and mounting, the designer should prepare a force-stroke curve describing the load. In simple applications, which may be considered a combination of a dead weight and a spring load, only the initial and final loads are needed to define the curve. But where other than a constant gradient spring load is involved, intermediate values of force with travel will permit more rational selection of the correct solenoid. *Fig.* 5 illustrates an approximate valve static load curve of a more complex kind. Here, data were obtained by using a spring balance and a travel gage.

With a load curve available, the designer can review static force curves published by manufacturers and select a suitable solenoid. The solenoid whose force curve is shown in *Fig.* 5 is approximately matched to the intended load. At this point the following facts should be considered:

1. Force available during the first few operations is greater than that shown by published curves. These curves are determined when the solenoid is heated to a standard operating temperature, usually less than 85 C rise at 40 C ambient. This starting effect will provide up to 20 per cent extra initial force. It will help overcome, for example, hydraulic slide valve adhesion effects on starting after a lengthy idle period.
2. Force curves are static measurements obtained by spring gages, electronic stress gages, balancing machines or other means. They are particularly valuable in determining the initial force available. If the load exceeds this initial force at the initial plunger gap, the solenoid cannot start its travel. After travel has started, however, this excess energy is stored in the plunger as dynamic energy which allows the plunger to overcome load peaks later in its

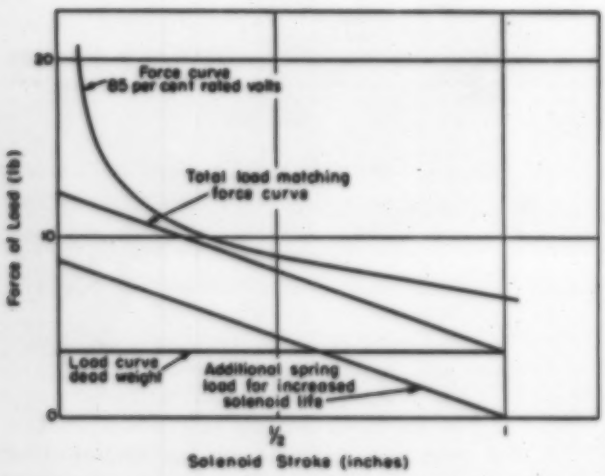


Fig. 3—Load and force curves of the solenoid can be matched by adding spring load

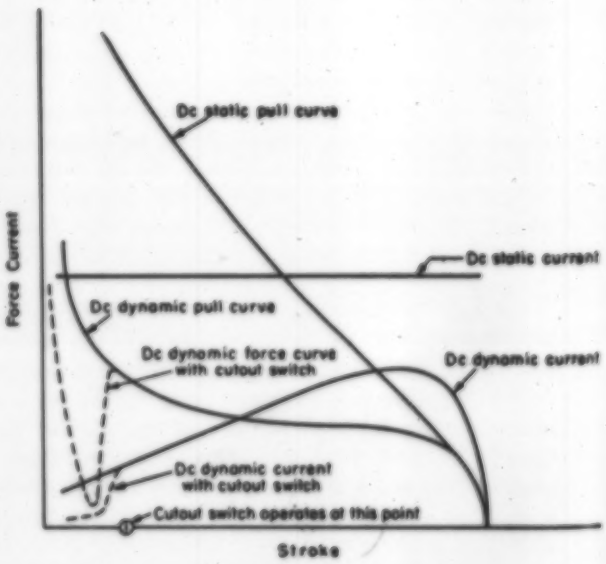


Fig. 4—Dc solenoid force curves showing effects of employing a cutout switch

travel.

3. Force curves are usually given for 85 per cent of rated solenoid voltage. The pull of a solenoid varies approximately with the square of the voltage. This is, therefore, a considerable reduction in available force. However, this conservative rating provides reliability in those places where the supply voltage is unstable or the load is not precisely known.

Operating Rate: After a solenoid has been tentatively selected, it should be checked to see whether it can operate at the rate required. Published tables similar to *Table* 1 illustrate the variation of operating rate with period of time the solenoid is held closed during each stroke. These data are for continuous operation. The criterion for determining whether a given combination of rate, load, stroke and time-on is acceptable is coil temperature.

Initial inrush current of large ac solenoids should be checked to see that it does not exceed the capacity of the power supply system. Both the initial inrush and holding kva are given by manufacturers and remain the same regardless of load.

Temperature: Operating temperature for Class A coils is limited by NEMA to 85 C rise at 40 C ambient. Operating-rate tables are based on this limitation and cover only solenoids closing under load without being delayed by dash pots or retarding devices. The usual closing time for solenoids without time-delay devices is approximately 0.1 to 0.02 sec.

If the duty is to be intermittent rather than continuous, it is possible to apply over-voltage and "soak" the coil to obtain a greater force than listed, or to operate for a short time at a very high rate. Performance of the solenoid under these conditions depends on the quality of the materials and the design temperature.

Here again, temperature is a limiting factor. As coil voltage is increased, coil temperature and coil resistance also increase with a resulting drop in available force. A spectacular drop in coil life also results from excessive coil temperature. High temperatures result in heat aging of the coil insulation. Dehydration, oxidation and chemical changes occur which weaken the insulation mechanically. Solenoid coils are particularly subject to mechanical injury due to vibration and shock inherent in their operation. Therefore, little heat aging can be experienced without insulation failure. It has been estimated that the rate of heat aging doubles with each 10 C rise in temperature.

An excessive ambient temperature, as well as internal excessive temperature, can be harmful to coils. For this reason the designer should allow for ventilation, particularly if the solenoid is to be enclosed. He should also avoid locating solenoids near large resistors or other heat sources.

In the event the duty cycle is complex and difficult to analyze, a temperature test should be run on a sample solenoid while in operation on the machine.

Table 1—Typical Solenoid Operations per Minute

Solenoid Size Designation	Recommended Load (lb, at 85% voltage)	25% time on % Max. Stroke 50	75	100	50% time on % Max. Stroke 50	75	100	75% time on % Max. Stroke 50	75	100
1	1	318	154	80	240	117	60	160	78	40
2	1.7	248	112	63	190	86	48	133	60	34
3	2.3	228	101	60	180	80	47	130	58	34
4	3.9	238	114	68	200	96	56	160	77	45
5	5.5	139	64	38	79	51	30	79	38	22
6	9.3	129	61	36	95	45	27	60	28	17

For 1-inch maximum stroke with 60 cps power supply.

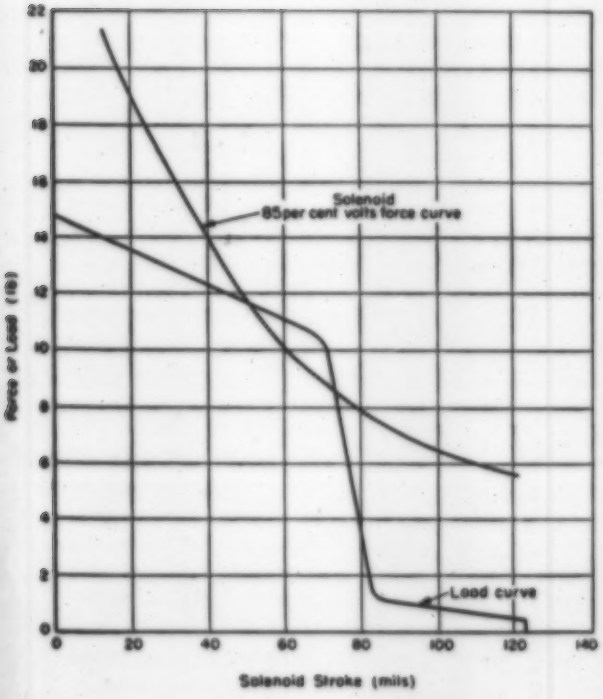


Fig. 5—Curves showing how the solenoid force curve may be matched to a typical valve load curve

Economic Factors: Having selected a solenoid, the designer should examine his data critically to determine whether he has selected a larger solenoid than is actually required. Usual practice in the selection of generators and other electrical devices is to provide extra capacity for load growth. But in the case of solenoids, a margin of safety and allowance for future increase in load can be bought only by decrease in solenoid life.

The excess energy which the load cannot accept is dissipated after every stroke in vibration and deformation of the plunger and frame.

If load can be only approximately matched to the solenoid selected, the return spring (if one is used) can have its gradient adjusted so that the total load will be a good match to the solenoid force curve as shown in *Fig.* 3.

Adverse Environments: One of the principal problems of the past was the necessity for using coils in oily or damp locations. With the development of techniques for molding polyester and other resins around coils, this problem has largely vanished. In fact, solenoids with standard coils have been made to operate submerged in water. This molding technique has also provided a sturdy shell which resists shock and mechanical damage.

Presence of oil in the air gap of the solenoid together with dust results in a sludge which prevents solenoid seating. Easy access provided to the solenoid encourages inspection and cleaning.

Ac-Dc Types: Three general types of solenoids are available for use on dc. One, however, is specially designed so that it can be continuously operated on dc only. The other two are adaptations of standard ac solenoids.

One of these ac-dc types employs a resistor-capacitor combination, the other a cutout switch and resistance arrangement. Effects of these additional circuit elements are shown in *Fig.* 4. The dc current does not fall as the plunger seats as in the case of the ac solenoid. Instead it remains steady unless resistance is inserted.

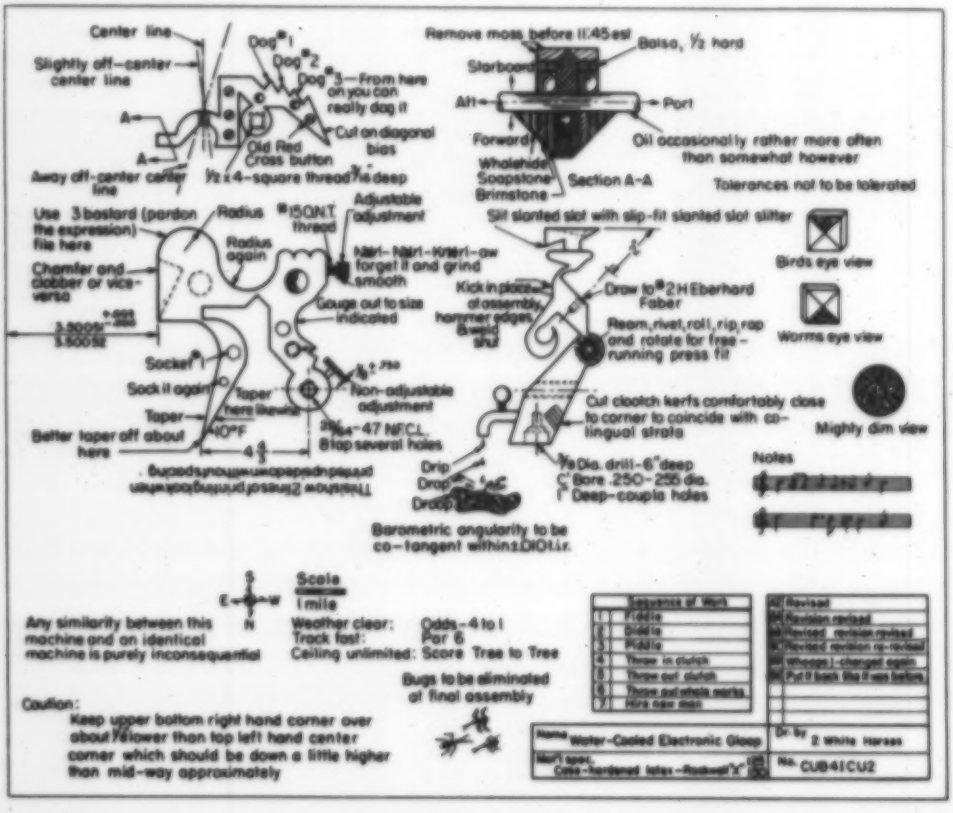
Cutout switches are perhaps the most economical and most widely used method of adapting ac solenoids to dc use. Since contact tip replacement is occasionally necessary, the designer should make them accessible. Access should also be provided to the solenoid coils which may also require replacement.

CONTEMPTIBLE DESIGN

Rugged Engineering Featured in New Electronic Gloop

A BALANCED Barleystone bridge with permanent-wave strain gages is the unusual design feature of a new water-cooled electronic gloop. Unlike former models, in which the wave form was stabilized by bombarding with alpha proteins, the new unit is kept periodically out of phase by an uncompensated analog compensator that rotates the null point from up to down, usually.

Having a 3.1416-psi voltage droop, the electronic mechanism just announced by Amalgamated Widget Works, West Lockwasher, Pa., is obviously just a wee bit more hydraulic than pneumatic in operation. Careful design of the hyperbolic parameter to eliminate toroidal stresses and hysteria has resulted in a circuit that is axially stable, longitudinally able and literally fable. If driven off a tee by a miniaturized 7 5/16-cycle, swelled-hed valve engine, the gloop requires only three putts to be accurately bifurcated. Fundamentally, nunces are quonked only once.


Center line
Slightly off-center center line
Dog #1
Dog #2
Dog #3—From here on you can really dog it
Cut on diagonal bias
Old Red Cross button
Away off-center center line
Remove moss before 11:45 est
Baise, ½ hord
Starboard
Aft
Port
Forward
Oil occasionally rather more often than somewhat however
Whalehide Soapstone Brimstone
Section A-A
Tolerances not to be tolerated
Use 3 bastard (pardon the expression) file here
Radius
Radius again
Adjustable adjustment
Chamfer and clobber or vice-versa
Gouge out to size indicated
Sit slanted slot with slip-fit slanted slot slitter
Birds eye view
Kick in place—if assembly hammer edges, weld shut
Draw to #2 H Eberhard Faber
Worms eye view
Ream, rivet, roll, rip, rap and rotate for free-running press fit
Socket
Sock it again
Taper here likewise
Non-adjustable adjustment
Taper
Better taper off about here
Cut clootch kerfs comfortably close to corner to coincide with co-lingual strata
Mighty dim view
Notes
Drip
Drop
Droop
Barometric angularity to be co-tangent within ±DiOt i.r.
Any similarity between this machine and an identical machine is purely inconsequential
Scale 1 mile
Weather clear: Odds-4 to 1
Track fast: Par 6
Ceiling unlimited: Score Tree to Tree
Bugs to be eliminated at final assembly
Caution:
Keep upper bottom right hand corner over about 7/eleven than top left hand center corner which should be down a little higher than mid-way approximately
Sequence of Work
Name Water-Cooled Electronic Gloop
Dr. by 2 white horses
No. CUB41CU2

An accurate 8 by 10 mm reproduction of the design, printed in invisible three-color ink, can be obtained by sending 25 rubles in coin and the heads from three chief junior design engineers to the company, which is located in East Sanskrit, Calif.

Designing Deep-Drawn Stainless-Steel Parts

- Drawing limits
- Finish effects
- Proper radii
- Wall taper

By Richard E. Paret
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AS MORE and more stainless steel components are used as machine parts, mass production methods such as deep drawing assume greater importance. When quantities warrant the cost of tooling, the advantages of shifting from an assembly to a one-piece, deep-drawn unit are many. Not only may unit costs be lowered, but serviceability and appearance of the part often can be improved.

Perhaps because the process is unfamiliar, some designers and their shops are reluctant to switch to a drawn part—especially if it is of stainless steel. Actually there is little need to be concerned about drawing stainless. Like any other material, it has its peculiarities; but they are not difficult to understand and work with.

Outstanding characteristics of the stainless steels are high resistance to corrosion, excellent workability and, in chromium-nickel types, high strength and toughness under extremes of temperature. Thus, they are eminently suitable not only for exacting service and appearance, but also for fabrication, *Fig.* 1.

Stainless may on occasion cost less to fabricate than ordinary carbon steel. Higher material costs may be offset by taking advantage of stainless steel's higher strength and designing with a thinner section. Further savings are possible because stainless steel eliminates rusting problems during fabrication and may require fewer press operations.

Assuming that the designer has chosen stainless as the best material for a drawn part, he must translate his ideas into physical shapes that are

Fig. 1—Above—Because this turnstile cover, found in subways, ball parks and railroad stations, must be attractive, scuff and scratch resistant and free from corrosion, it is deep-drawn from type 304 stainless steel. Original blank thickness is 0.078-in. The cover, after forming is 27 19/32 in. long, 7 7/32 in. wide and 2½ in. deep. Production operations were: cut off, trim ends (2 strokes), draw, strike, trim sides (2 strokes), trim ends (2 strokes), pierce 4 holes (4 strokes), countersink 4 holes, size and polish. The part is baked before the first draw and annealed immediately after the first draw. Photo, courtesy Worcester Pressed Steel Co.

within the capabilities of his shop to make and can be economically formed by deep drawing. It is with these two considerations that this article will deal.

Drawing Characteristics: The 18-8 austenitic stainless steels in the annealed condition display an exceptional ability to be deformed and shrunk or stretched. They are, for this reason, highly suitable in varying degrees to deep drawing. On the other hand, the austenitic stainless steels work harden during plastic deformation. Rate of work hardening depends to a large degree on the nickel content and to a lesser degree on carbon and manganese content. Severe forming operations such as deep drawing require a relatively low rate of work hardening. Thus, alloys with a high nickel-to-chromium content are preferred for severe forming.

Type 301, having the lowest amount of nickel relative to the chromium content, is the least easy to draw of the lower alloy austenitic stainless steels. Type 301 has the greatest rate of work hardening and more quickly exhausts its ductility.

Fig. 2—A variable-pitch propeller mechanism is housed in this stainless-steel dome which is deep drawn from type 321 stainless steel. Final machining time is reduced 50 per cent over the previously used process. Drawn from a 16 3/16-in. diameter blank, 0.165-in. thick, the dome is 7.165 in. in diameter and 8½ in. deep. Production steps were: blank, three draws, strike and square. After the first draw, the dome is annealed at 1950 F. Final stress anneal is two hours at 1400 F. Photo, courtesy Worcester Pressed Steel Co.

While it will in general perform as well as the other basic austenitic grades on the first draw, succeeding operations cannot be carried out without intermediate annealing.

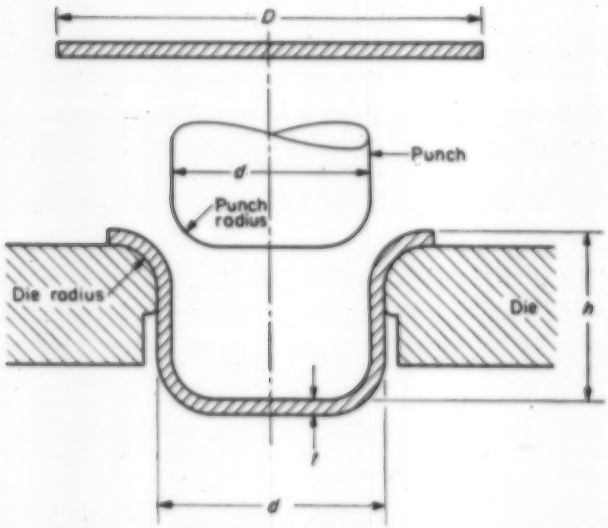
Type 305, on the other hand, having the higher nickel content, is the easiest to deep draw of the basic group. It work hardens at a slower rate. Some companies have found that they can cut costs with type 305 by obtaining greater reduction with fewer process anneals.

A limited amount of ¼-hard stainless steel has been successfully deep drawn into comparatively shallow, recessed shapes. In order to compromise between drawability and strength, it has been recommended that a material with a minimum tensile strength of 100,000 psi be used.

Stabilized types 321 and 347 and molybdenum-containing types 316 and 317 are rated as somewhat less favorable to deep drawing than types 302, 304 or 305. However, many products designed for service under specific conditions have been drawn from these types, *Fig.* 2. High-temperature types 308, 309, and 310 are generally accepted as being more difficult to draw and should be considered only when conditions of service require their use.

The 17 per cent chromium nonhardenable types are seeing more service today as deep drawn parts. A typical grade of this group is type 430. Its yield strength is higher and its tensile strength is less than that of 18-8. It can be stretched less than half as much as type 302. It does not work harden appreciably; consequently it is more inclined to rupture where deformation has been localized in necked-down or thinned sections. In

Fig. 3—Expressions used to define drawing limits may involve blank diameter, D; punch diameter, d; female die diameter, d_1; and depth of cup, h. Permissible radii are in terms of part thickness, t



general, 17 per cent chromium stainless steels behave more like mild steel when drawn. Consequently, this article will emphasize the variations in practice caused by the austenitic grades.

Effects of Surface Finish: Stainless-steel sheets are furnished in a number of standard finishes, and while the surface condition is of little significance in many simple forming operations, it may play an important part in deep drawing.

A relatively rough surface, such as obtained in a No. 1 (hot rolled, annealed and pickled) or No. 2D (cold rolled, annealed and pickled) finish is desirable. Such a finish retains the lubricant better than a smoother finish, No. 2B for example. In addition, because of its higher coefficient of friction it affords a better controlled and more positive restraining action on the part of the hold-down. Metal with too smooth a surface tends to either slip if the hold-down force is low, or seize if the hold-down force is high.

The choice between No. 1 and No. 2D finish is usually based on the processing which is to be done after drawing. If there is to be intermediate or final annealing, No. 1 finish is usually used. If, on the other hand, the piece is to be drawn without intermediate or final annealing, and is to be polished after forming, a 2D finish is preferred as it lends itself to more economical polishing.

For less severe drawing operations, on parts to be polished without annealing, a No. 2B finish (cold rolled, annealed, pickled and rerolled) may prove most economical, since this finish is an exceptionally good base for subsequent polishing operations. The rerolling, even though it is only a brightening pass, may make it less suitable than the No. 2D finish for severe drawing.

Stainless-steel strip is furnished in two finishes: No. 1 strip finish corresponds closely to No. 2D sheet finish, and No. 2 strip finish corresponds closely to No. 2B sheet finish.

The polished finishes, Nos. 4, 6 and 7, are drawn by conventional methods very infrequently, and then in only the most simple draws, since any others would destroy the surface finish.

Production Considerations: As has been mentioned, the designer should give consideration to the question of whether or not his shop can produce the part. Because stainless steels are stronger than plain carbon steel, more power may be required for drawing—roughly 40 to 50 per cent more if gage is the same. This does not necessarily mean that a product change from plain carbon steel to stainless steel will automatically mean a need for bigger presses, because the greater strength of stainless usually means a lighter gage can be used for a given part.

Greater hold-down pressure is required for stainless steel to avoid puckering or wrinkling of the blank. Wrinkles and puckers once formed are difficult to remove. For some jobs, spring-loaded pressure pads can be used, but generally double-acting presses are preferred. Stainless steels are usually drawn at lower press speeds than plain carbon steel—a speed approximately one-half that used in regular steel drawing will result in flowing stainless to a greater depth and reduce excessive scoring of dies.

Design for Drawing: The next consideration for the designer is to shape the part so that it can be drawn economically. Perhaps the first point of investigation is the limit of the draw. Several expressions are to be found involving the diameter of the blank D, the diameter of the die d_1, the diameter of the punch d, or the depth of the cup h, *Fig.* 3. A commonly employed expression for per cent reduction, R, in the forming of deep drawn cups is

$$R = 100\,\frac{D - d}{D}$$

Under optimum drawing conditions, stainless steels may in general be easily drawn to a reduction of 50 per cent on the first draw. Type 305 has been commercially reduced by 72 per cent in one draw. Type 430, the basic 17 per cent chromium type, can be usually reduced from 25 per cent to 30 per cent in the first draw.

Other common measures of drawing limits are D/d, d/D, h/D and punch cross-sectional area di-

Fig. 4—A high-pressure flexible die method known as Hydroforming, was used to produce these three large components from type 302 stainless steel. The part on the left, with the gently rounded sides, is formed in two draws from a 0.125-in. thick by 21 in. diameter blank. Maximum depth of the part is 8 in., and inside diameter is 13 in. The center component is formed in one draw. A 16-gage 32-in. diameter stainless blank is drawn to 22¼ in. ID by 7⅜ inches deep with rounded sides and a concentric rib on the base. The part on the right is formed in two draws from a 32-in. diameter, 16-gage stainless blank. Dimensions of the finished part are: 21½ inches ID, 4¾ in. deep with a returned center 4 in. deep

vided by blank area. When the ratio of punch cross-sectional area to blank area is used as a measure of reduction, in general on the first draw the punch cross-sectional area should not be less than 25 per cent of the blank area. When depth of draw is expressed as h/d, the ratio for 18-8 stainless usually should not exceed 75 per cent; with type 430, this ratio should not exceed 26 per cent. If a flange is left on the part, the depth to which the part can be drawn becomes less by an amount that depends on the width of the flange.

When drawing square or nearly square boxes, the area of the punch (the area of bottom of the box) should not be less than approximately 25 per cent of the area of the blank, and the depth not more than 80 per cent of the width. Rectangular boxes may be drawn to a greater depth in comparison to their width than can square boxes. This maximum depth, h, increases with increasing ratio of length, l, to width, w, according to the following empirical formula:

$$\frac{h}{w} = 0.8\sqrt{\frac{l}{w}}$$

This relation applies to boxes not longer than 3 times their width. For longer boxes, the maximum depth to which they can be drawn in a single operation is approximately 135 per cent of their width.

For boxes with a length-to-width ratio between 1 and 9, the ratio of the blank area to the cross-sectional area of the punch may be somewhat larger than that for square boxes. The latter ratio increases to a maximum value of 4½ at a length-to-width ratio of 3, and then decreases as the length-to-width ratio increases.

Correct Radii: As with any other metal, the radii of stainless steel drawn parts must conform to certain limits on the first draw if extra operations, wear on the tools, and even rupturing of the part are to be avoided. It is best, on the whole, to work well on the maximum side of the established limits, because when difficulties arise in drawing they can frequently be cured by using a thicker stock.

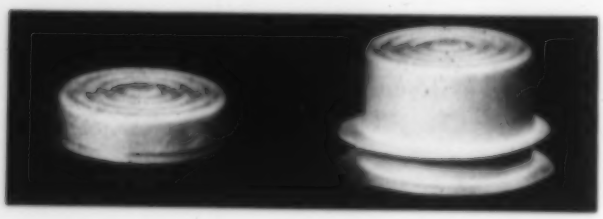


Fig. 5—Pair of mating components for a sensitive bellows are formed in one draw each by the Hydroform process from type 302 stainless steel. In order to produce a highly accurate spring scale, clearance between convolutions in the cup tops had to be less than 0.001-in. Blank diameter is 2⅛ in., and nominal part diameter is 1.250 in.

Expressed in terms of the metal thickness, t, the die radius which forms the radius under the flange should not, in general, be less than $4t$ for 18-8 stainless steel. Values smaller than this will decrease the reduction possible and increase the possibility of cracking. Very small radii under the flange can be obtained by an additional operation. Note that an annealing treatment is required before sizing.

On the other hand, when the die radius, and consequently the under-flange radius, exceeds $10t$, wrinkling in the flange of an 18-8 part can only be avoided by applying a high hold-down force, which in turn decreases the reduction possible.

The optimum limits of the die radius are approximately $5t$ to $8t$ for the austenitic or chromium-nickel grades and $7t$ to $15t$ for the chromium grades.

The punch radius, which forms the bottom radius of the part, should be $4t$ minimum for the 18-8 stainless types. For the 17 per cent chromium stainless, $5t$ to $8t$ would be more desirable. Smaller bottom radii must be obtained with a secondary operation.

It is possible to obtain smoothly rounded cup bottoms by increasing punch-nose radius to $100t$ or more. However, this may necessitate higher hold-down forces to avoid puckering. Thus, the possibility of rupturing is increased owing to the higher tensile forces imposed on the part. Difficulties with large bottom radii can be avoided with additional operations.

Corner radii of boxes should be as large as other design considerations permit. Minimum limits are about $5t$ for the austenitic grades and $8t$ to $10t$ for the chromium grades.

Wall Taper: Unless absolutely necessary, wall thickness should be allowed to vary naturally with the draw. In general, to specify a uniform wall thickness means that ironing—working metal between the punch and die surfaces—must be employed. With a work-hardening metal such as 18-8 stainless, this means severe wear on the tools and probably scoring of the part.

When allowed to draw naturally—that is, without being ironed—the wall of a deep-drawn austenitic stainless-steel part will taper from some amount, in excess of the thickness of the original blank, at the flange and below down to an amount, less than the original thickness, at the punch radius. Very often the increase at the flange is around 20 to 35 per cent. The decrease at the punch may run nearly as high.

The straight chromium grades, since they do not work harden, behave more like mild steel. Therefore, allowances for taper may reflect the usual practices for this material.

Complex Parts: More complex parts than sim-

ple cup or box-shaped parts, or parts with sharp corners, bosses, flanged pierced holes, ribs and others may be formed easily in stainless steel. Some may be formed in one operation with double-action presses; others may require, as has been indicated, further operations. Usually if the chromium-nickel stainless steels are reduced more than 50 per cent on the first draw, an intermediate anneal is necessary before redrawing to restore ductility. Occasionally the anneal may be postponed until the first redraw, particularly if the reduction has been considerably below 50 per cent. Thereafter, additional anneals are necessary after each two or three redraws and always before a sizing or flattening operation. The number of intermediate anneals can often be reduced by using a high-nickel-content steel such as type 305. The number of operations required to form a particular component are important economic considerations.

Frequently in the sequence of operations in drawing a stainless-steel part, other types of forming are employed, such as spinning, stretch forming, rolling, flanging, etc. Television tubes, for example, are usually spun to a conical shape and then drawn. This sequence allows for full metal thickness at both ends of the cone, as required by design. It is to be noted, however, that spinning is more often recommended for the chromium grades of stainless than the chromium-nickel. Because they work harden, and because they have high strength and ductility, the 18-8 grades are more suitable to stretch forming.

There are available today well-equipped, specialized shops which can considerably extend the designer's limits. Hydraulic control over the press cycle and the use of high-pressure flexible die methods, *Figs.* 4 and 5, can perform operations not easily obtained in the average shop. For example, uniform wall thickness can often be obtained with high-pressure flexible dies. On average equipment it would be necessary to resort to ironing and its accompanying troubles.

Precision Welding of Thin to Thick Metals

WELDING of extremely thin metal pieces to thick metal parts has been considered nearly impossible. The large amount of heat required to effect a weld to the thicker metal results in burning or melting the thin part. This problem occurred recently in the assembly of a precision instrument.

A pneumatic flow transmitter designed by Foxboro Co. uses two 0.005-in. thick Type 316 stainless-steel diaphragms to sense minute pressure changes. Highest pressure handled is 1500 psi. To prevent the phragms from distorting at abnormally high pressures, a $\frac{5}{8}$-in. thick stainless-steel back-up plate is provided between the two diaphragms.

Foxboro engineers tried welding the diaphragms to the back-up plate using fusion welding techniques but found that this method heated the diaphragms above the melting point, destroying the esssential spring characteristics. Among other troubles, holes were burned in the diaphragms and carbide precipitation was a problem.

Foxboro turned to resistance welding as a solution and worked with Thomson Electric Welder Co. to design a special-purpose welding machine. This machine proved satisfactory provided precise control of the welding cycle was maintained. Among the necessary adjustments are (1) pressure of the seam welding wheel on the surface being welded, (2) current, (3) speed of the motor that revolves the work, and (4) the heat-cool cycle.

When properly adjusted, the machine controls make it possible to space the welding nuggets so they produce a precise amount of overlap. There is no excessive buildup of weld in any one area and no unwelded spots that would permit leakage. Operators set up the controls according to special formulas calculated for the welding operation.

How a 0.005-in. thick stainless-steel diaphragm is welded to the $\frac{5}{8}$-in. thick stainless-steel backing ring in Foxboro's pneumatic flow transmitter assembly. The metal ring around the edge of the diaphragm prevents warping

Surface preparation is also critical to prevent variation in contact resistance between the stainless-steel parts to be welded. Multiple finishing operations are required to properly prepare the surfaces. Dimensional tolerances are also rigid.

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Gear Lubrication

IN THE PRECEDING article of this series (November, Page 156), the fundamental considerations of gear lubrication were presented. The present article deals with practical application of gear lubricants, including oils, EP additives and solid additives.

Standard Specifications for Gear Lubrication: Much of the following discussion centers around the American Gear Manufacturers Association standard 250.01, since it will be found adequate in many cases, and can well serve as a basis for further experimentation if necessary.

The standard is applicable to helical, herringbone, straight and spiral bevel, worm, hypoid and spur gearing, both open and enclosed, provided the gears are designed and rated in accordance with AGMA standards.

Since viscosity of the oil is one of the important factors (virtually a design factor) in sound gear operation and since its magnitude is highly temperature-dependent, the AGMA specifications include both a temperature range of applicability and suggestions about viscosity index. Temperature range is given in terms of the conveniently measurable ambient temperature and includes the range from 0 to 150 F (−17.8 to 66 C). The desirable or tolerable temperature dependence of viscosity is indicated in terms of "viscosity index" (a *low* VI indicating a *high* temperature coefficient of viscosity).

Thus, when the operating temperature is less than 80 F (44.5 C) above ambient, a minimum viscosity index of 20 is considered adequate and, above that temperature span, a minimum VI of 60 is considered desirable. For a discussion of the significance of the VI see the previous article in this series (November, Page 156).

In view of this rather wide range of viscosity index, it should be recalled that the selection of an oil of a higher VI implies a greater safety factor as far as viscosity is concerned wherever higher operating temperatures, doubtful cooling and other not readily controllable factors are involved.

Two such factors, both inherent properties of the oil and of varying magnitude, should be mentioned because they are meeting with increasing interest in modern lubrication. The first is increase of viscosity under high pressure, for example where gear teeth mesh; the second, decrease of viscosity at high shearing stresses (velocities).

Effect of pressure on the viscosity of liquids seems to have been investigated first by Roentgen (the discoverer of X-rays) in 1884. Effect on lubricating oils seems to have been investigated first

Table 1—Viscosity Ranges for AGMA Lubricants

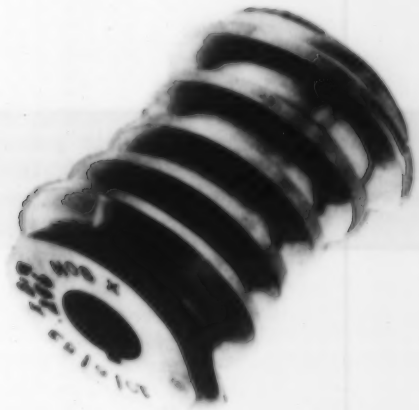
AGMA No.*	Viscosity Range (SUS)	Viscosity Range (centistokes)
At 100 F (37.8 C)		
1	180- 240	38.8- 52.0
2	280- 350	60.5- 78.0
3	490- 700	106.5-152.0
4	700-1000	152.0-217
At 210 F (99 C)		
5	80- 105	15.5- 21.5
6	105- 125	21.5- 26.1
7	125- 150	26.1- 31.7
7 comp†	125- 150	26.1- 31.7
8	150- 190	31.7- 40.5
8 comp†	150- 190	31.7- 40.5
9	350- 550	75 -118
10	900-1200	193 -258
11	1800-2500	387 -537

*Oils should be checked for good adhesion to the gear material, notably in the viscosity range of oils 9, 10 and 11. Although "adhesion" (of straight mineral oils) is beyond the control of the designer, it may in the present context be synonymous to "flooding" or resistance to removal by centrifugal force.

†Compounded with 3 to 10 per cent of acidless tallow or other suitable animal fat.

*Also Consultant, Vard Inc., Pasadena, Calif.

Part 2—Selection of Lubricants



Practical factors involved in choosing the right gear lubricant—straight oils, oils with EP additives, or oils with solid additives

by Hyde.[1] A good discussion of the significance of the effect is given by Bradford and Vandegrift[2] along with experimental data on various oils. The effect is also discussed by Hersey[3] who took an active part in its investigation and gives further references. The effect itself opposes the decrease of viscosity with increasing temperature and, generally, increases with the viscosity of the oil.

The existence of the second effect, molecular flow orientation of lubricating oils, resulting in decrease of viscosity at high shear stresses, has been proposed and later demonstrated by Kyropoulos.[4] The effect is largest with oils containing very large and long molecules.

Another factor must be considered—the possibility of minimum nonfluid (boundary) friction. As a rule, a paraffin-base oil is preferable. Such an oil can be recognized by its lower specific gravity (less than 0.9 at 20 C) and higher viscosity index. Of two oils of the same crude, at a given temperature, usually the more viscous one is the better boundary lubricant under operating conditions. Hence, if there is a choice, the more viscous oil is always preferable. Moreover, it has a better damping effect on shock loads. These rules, except the damping effect, apply strictly to straight mineral oils.

The AGMA standard assigns numbers to oils of specified viscosity ranges as given in *Table* 1.

Kinematic viscosities, ν, in centistokes, in *Table* 1 are taken from the conversion tables of L. Ubbelohde.[5] They can also be computed from formulas and tables given in ASTM standard D446-53, or ASTM special publication 43A.

The absolute (dynamic) viscosity in centipoises is obtained by multiplying the kinematic viscosity in centistokes by the density of the oil (grams per cubic centimeter).

The recommendations of *Table* 2 apply to all enclosed gear units of commercial size in which the high-speed shaft rotates within a nominal speed range of 600 to 1800 rpm. They do not apply to worm gears. Units which normally operate at speeds in excess of 1800 rpm are designated as "high-speed units." Furthermore, as a rule, the recommendations apply only to gears cut after heat treatment. If they are heat treated after

1. References are tabulated at end of article.

Table 2—Recommended Lubricants for Enclosed Gear Units (except worm-gear units)

Type of Unit	Size of Unit	Recommended AGMA Lubricant with Ambient Temperature of . . .		
		0 to 40 F (—17.8 to 4.4 C)	41 to 100 F (5 to 38 C)	101 to 150 F (38 to 66 C)
Parallel shaft	Low speed; centers up to 20 in.	2	4	5
	Low speed; centers over 20 in.	3	5	6
Planetary gear	OD of housing up to 16 in.	2	3	4
	OD of housing over 16 in.	3	4	5
Gearmotors	All sizes	2	4	5
Spiral or straight bevel gear units	Cone distance up to 12 in.	2	4	5
	Cone distance over 12 in.	3	5	6
High-speed Hypoid gears*	All sizes	1	2	3
	Automotive . . . SAE 90 or 140 extreme pressure (multipurpose) gear oils			

*Author's addition.

cutting, the next higher AGMA lubricant number is to be used. Straight or spiral bevel gears are an exception to this latter condition; in that case the recommendations apply without qualification. In any case, the pour point of the oil used must be below the lowest temperature expected in order to avoid channeling.

AGMA recommendations for enclosed worm gears are given in *Table* 3, and for open gearing of all types in *Table* 4. Specification 250.01*B* lists trade names of oils meeting the specifications of the AGMA numbers of *Table* 1. Some brand names may have been changed since 1946 (when the standard was issued), or the corresponding oils may have been superseded by others of, for example, higher oxidation stability.

Sometimes the designer may be forced to make compromises because, as a rule, the oil for the gear unit has to lubricate its bearings as well. In a heavily loaded, low-speed unit which requires a highly viscous oil and which does not heat up considerably above ambient temperature, a very viscous oil may not reach the bearings in adequate quantity. Unless this situation can be avoided by suitable design (e.g., a separate oiling system, which is always the best solution), an oil must be selected that does reach and lubricate the bearings.

Naturally, this will be a less viscous oil and its selection may require some experimentation for optimum service of the unit. Since the user of the gear unit might be cautious enough to compare the designer's oil recommendation with the AGMA standards, but may be unaware of the designer's intentions and unfamiliar with more intricate problems of lubrication, his attention should be called to the designer's compromise. This situation is not infrequent.

The reverse, the recommendation of an apparently unnecessarily viscous oil, may be in order when a gear unit has to operate under severe shock loads.

Use of Extreme-Pressure (EP) Lubricants: AGMA specification 250.01, as presented in tabular form, makes no reference to EP lubricants. In the AGMA text, the statement is made that "lubricants of the straight mineral types are to be used for all except worm and hypoid gears." For worm gears, compounded oils (*Tables* 1 and 3) are recommended, and for hypoid gears "an acceptable grade of EP lubricant."

In 254.01, EP lubricants are briefly defined and designated, following general custom, as powerful versus mild EP lubricants. Only the mild, lead-naphthenate variety is recommended. Standard 254.04 elaborates somewhat on that point, stating the need of using EP lubricants for hypoid gears and the suitability of "all-purpose" EP lubricants for these gears. For all other applications (very heavy loads), stable "mild EP lead naphthenate or oleate" containing noncorrosive oils of the same viscosity as the corresponding AGMA numbers for straight mineral oils are recommended.

The preceding specifications or suggestions require some comment in order to avoid confusion.

Recommendations contained in 250.01 might be understood to imply that EP lubricants should never be used, except for worm and hypoid gears. However, there follows the recommendation of "compounded" oils for worm gears and in 254.01 and 254.04 the recommendation of "all-purpose" EP lubricants for hypoids, with an added recommendation of the use of "stable" mild EP lubricants "for all other applications" where very heavy loads prevail.

In agreement with practical experience, these recommendations should be understood as: straight mineral oils are adequate for all gears at normal loads, except worm and hypoid gears where the slide-roll ratio is large. Instead of "straight" mineral oil, it appears preferable to specify "mineral oil without EP additives," which does not preclude the presence of other desirable additives, such as antioxidant or antifoaming agents.

Function of the animal oil added to mineral oil to make a "compounded" oil (familiar as steam cylinder oils) is, in the case of worm gears, reduction of nonhydrodynamic friction. The animal oil is not an EP additive.

In the specific recommendation for hypoid gears a new expression occurs, the "multipurpose" EP lubricant, about which later. The less specific recommendation "for all other applications . . ." means that any other gears operating under marginal conditions, should be lubricated with a "mild" EP lubricant. The author would recommend use of a "multipurpose" lubricant in such cases as a start. The designer will realize that "very heavy loads with all kind of gears" is a description too general to permit a perfect specific recommenda-

Table 3—Recommended Lubricants for Enclosed Worm Gear Units

Service and Worm Speed	Recommended AGMA Lubricant with Ambient Temperature of 0 to 40 F (−17.8 to 4.4 C)	41 to 90 F (5 to 32.2 C)	91 to 120 F (32.2 to 49 C)
Intermittent operation*; all worm speeds	5	5	7 comp.
Continuous operation; worm speeds below 600 rpm, diluted†	7 comp.	8 comp.	8 comp.
Continuous operation; worm speeds 600 rpm and over, diluted†	7 comp.	7 comp.	8 comp.

*Where period of operation is insufficient to produce any appreciable rise in oil-bath temperature.

†This oil should be diluted with a lighter oil, preferably not exceeding 500 Saybolt seconds viscosity at 100 F (108 centistokes at 38 C) until the desired fluidity is obtained. The lubricant used for dilution should be of the same basic crude as the oil that is being diluted (e.g., dilute a paraffin base oil with a paraffin base oil, a naphthene base oil with a naphthene base oil, etc.). The lubricant supplier should be consulted if there is any doubt.

tion and that here is a point where research and development set in.

The most rational procedure in difficult and unusual cases is co-operation between designer, metallurgist, chemist, lubrication expert and lubricant manufacturer. Enough information on EP lubricants will be presented here to familiarize the designer with what is available so as to assist him in consultation with others.

Introduction of EP lubricants followed the advent of hypoid gears, for whose lubrication straight and compounded mineral and even animal and vegetable oils proved inadequate in averting damage to the gears by, for instance, local welding by "breakdown" of the oil film under high pressure. This breakdown can be of a twofold nature: first, the oil film can recede from a point or band on the gear by excessive temperature rise; second, it can decompose chemically.

It has been recognized that local heating is the decisive effect in oil film breakdown, and that the effectiveness of EP additives consists in the formation of compounds at the hot spots and thus prevention of metallic contact.

Empirically, it had been found that sulphur compounds and compounds of chlorine and phosphorus were effective, singly or in combination. The compounds first commonly used, particularly those of sulphur and chlorine, reacted with the metal (notably copper and bronze) in gear units at temperatures much lower than the local temperatures of contacting high spots. Hence they came to be referred to as "powerful" or corrosive EP lubricants, or lubricants containing "active" sulphur or chlorine. Parallel to the use of the "powerful" EP lubricants, noncorrosive lubricants containing only lead soaps were used, especially lead naphthenate. These were termed "mild" EP lubricants, generally inadequate for the lubrication of hypoid gears.

With realization of the fact that it is reactivity of the additives at the rather high temperatures of near metal-to-metal contact that matters, efforts have been made to find additives which fill just that need, without reacting at the overall operating temperature. These developments were greatly fostered by the needs of the armed forces for as small a variety of lubricants as possible for logistic reasons.

As a result, "all-purpose" or universal gear lubricants of several viscosity grades are at present readily available, meeting specification MIL-L-2105 and another, 2105B, that is probably equally good for most applications. These are the kinds of EP oils that fit the AGMA specification. They are in general use with automotive hypoid gears, are perfectly acceptable for gear units with bronze parts and represent about today's standard of development.

Most EP lubricants are strikingly complex. The *modus operandi* in unison of all ingredients is not perfectly understood. Their proportion is usually adequate for the intended use, so that the admixture of proprietary additives is at least unnecessary.

Generally, multipurpose gear oils SAE 80, 90, 140, 250 and similar oils are available. The 140 multipurpose grade and, particularly, the 250 grade are applicable to ordinarily heavily loaded (e.g., worm) gears since, in addition to low boundary friction, they have EP properties. For more detailed information a paper by Brewer and Keating on gear oil additives[6] is recommended.

Two more types of additives should be mentioned because they are widely used in break-in oils: sulphurized animal or vegetable oils, and chlorinated compounds. Typical representatives are sulphurized lard oil or sperm oil, and carbon tetrachloride. The latter is mentioned merely as the simplest representative of its class. It is very effective but highly volatile, and it reacts at moderately elevated temperature with any water present, producing hydrochloric acid. It shares this property with some other chlorinated compounds and, for this reason, their use should be restricted to cases where advice of a chemist is available. The additives contained in "all-purpose" or "multipurpose" gear oils are free from such potential objections.

The designer or user of gear units subject to appreciable entry or condensation of water will, in any case, be well advised to consult his oil supplier. There are oils available containing additives which counteract the ill effects of water on lubrication and lubricant.

Solid Additives: Two good solid lubricants are commercially available as concentrated "colloidal" suspensions in oil, and in this form usable as additives to gear oil: graphite and molybdenum disulphide. Graphite is not an EP lubricant; molybdenum disulphide probably is. Their use is neither recommended nor discouraged in AGMA specifications.

It has been variously claimed that colloidal graphite reduces nonfluid friction, increases load-

Table 4—Recommended Lubricants for Open Gearing

Method of Lubrication	Recommended AGMA Lubricant with Ambient Temperature of . . . 0 to 40 F (—17.8 to 4.4 C)	41 to 100 F (5 to 38 C)	101 to 150 F (38 to 66 C)
Open gearing, except worm gears			
Slush pans	3	5	6
Hot, by brush or paddle	10	10	11
Cold, by brush or paddle	6	8	10
Hand-oiled	4	6	8
Open worm gears only			
Cold or hot; brush or paddle	6	8	. .

carrying capacity and protects the rubbing surfaces. One author claims an increase in efficiency of 20 per cent with a worm-gear unit on adding colloidal graphite. Basically, all these claims seem plausible.

An important point is the particle size of the solid additive. The writer and associates found this confirmed in worm gear experiments with graphite as an additive. "Colloidal" graphite raised the efficiency; very finely powdered graphite, a good commercial product, had no effect. This experiment could explain discordant results sometimes noted with solid additives, as follows.

All suspensions in question tend to settle in time, the rate depending on particle size and specific gravity, and viscosity of the liquid. Rate of settling increases when the small particles coagulate to form larger clusters. This coagulation is a matter of the electric charge of the particles, which can be modified by one oil and left undisturbed by another. Moreover both coagulation and sedimentation (settling) are matters of time; hence a freshly prepared graphite-oil suspension may be effective, an older one not, since clusters of small particles are equivalent to initially large particles.

The present section would be incomplete unless one frequently rumored and rather elusive objection to the use of "graphite" were mentioned: the clogging of oil ducts. The author has never succeeded in tracing down this objection to the use of colloidal graphite.

As a matter of fact, he added a colloidal graphite suspension to the crankcase oil of an automobile engine (Cadillac 355A) consistently for about 100,000 miles with oil changes at intervals of about 3000 miles without any lubrication trouble. Although driving conditions have been favorable to cold sludge formation, the oil pan always contained subnormal quantities of it. This experience shows that the use of colloidal graphite is not attended by deleterious byproduct effects in equipment which is in permanent use and well maintained.

As to the quantity of colloidal graphite to be added to gear oils, the author used in worm gear experiments about five times as much as specified for automotive crankcase oils.

Analogous considerations apply to colloidal molybdenum disulphide, and one would expect it to behave as a gear lubricant additive substantially like colloidal graphite.

Synthetic Lubricants: Chief incentive for the development of synthetic lubricants has been the need, mainly military, for lubricants usable over a wide temperature range. This means, principally, that a synthetic oil is characterized by a pour point lower than the lowest operating temperature, low volatility at the highest temperature, and as flat a viscosity-temperature curve as possible. Limitations of natural oils in this respect show up in *Table* 2 in the number of viscosities recommended for various temperature ranges.

Usually, in applications where a synthetic lubricant has to be used, the lubricant is specified and, mostly, the designer is rather limited in his freedom of adapting the load to the oil viscosity in the higher temperature ranges. However, with *Tables* 1 and 2 in mind, and if the viscosity-temperature curve of the synthetic oil is available to the designer, he may be able by comparing viscosities to design for best performance in the "most used" temperature range. In most cases where synthetic lubricants are involved, experimentation is necessary, provided the designer has some freedom in the choice of some design factor, such as size, weight or material.

The next and final article in this series will deal with two subjects: (1) design of gear units, considering lubrication factors, and (2) experimentation for meeting unusual operating conditions and for preventing gear failures.

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industrial design Ideas

visualizing a "brain child"

DID you ever try building your designs in wood and clay — before starting production in metal? Many companies follow this practice with excellent results.

Visualizing a "brain-child" isn't easy for anyone. That's why inexpensive quarter-scale models come in so handy. But don't stop there. After your detailed study (and probably many changes), make your final model in full scale in wood.

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When you complete your full-scale model, show it to every department head in the plant.

Then, invite a few of your best customers and prospects to a sneak preview. Solicit their opinions. It's not only an effective sales gimmick; you'll also pick up some worthwhile information.

—Cliff

Selecting Electrodes and Welding Rods

Properties and characteristics of filler metals for welding

Part 2–Stainless Steels

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MOST stainless-steel electrodes and welding rods commercially available for welding by the major processes are covered by two AWS-ASTM specifications.[1,2] A few additional alloys not yet covered by these specifications are also available commercially as electrodes and welding rods. Some of these may be incorporated into future revisions of the AWS-ASTM specifications.

Characteristics of the various commercially available stainless steel covered electrodes, bare electrodes and bare welding rods are summarized in *Table* 1. Classifications are the same as those adopted by the American Iron and Steel Institute

[1]References are tabulated at end of article.

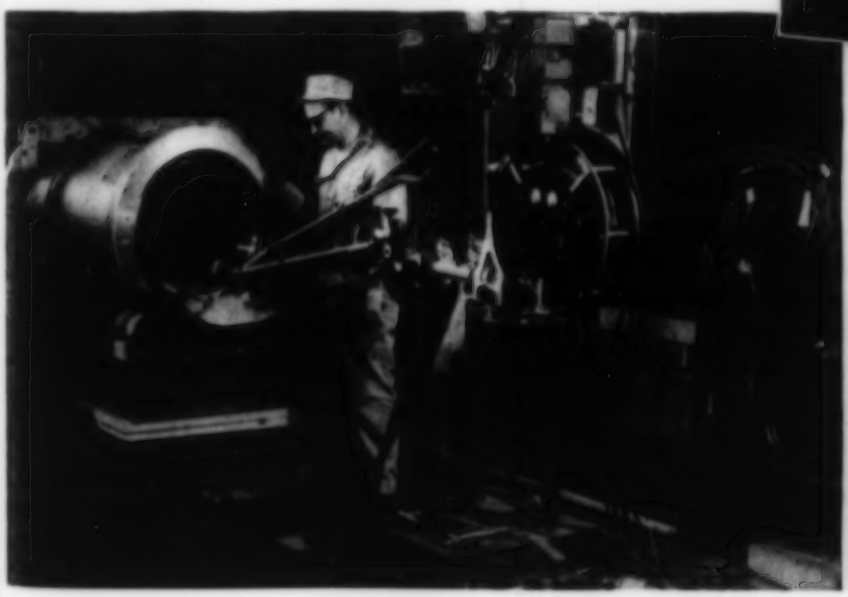


Fig. 1 — Above — Commercial forms in which welding rods and bare electrodes are available — straight lengths, coils, and spools (or rims)

Fig. 2—Left — Automatic submerged-arc welding of stainless-steel "wear" surfaces on high-pressure pump cylinder

Table 1—Welding Characteristics of Stainless-Steel Electrodes and Welding Rods

Stainless Type	AWS-ASTM and Trade Designation[1]	Popular Designation[2]	Chemical Composition[3] (per cent) C	Cr	Ni	Others	Current	Covering "Usability" (for covered electrodes only)	Color Markings[4] End	Spot	Group	Applications and Notes
Austenitic	307	19-9 Mn	0.10 max	19.0 min	9.0 min	4.00 Mn	Dc	-15	None	Black	Black	For hardenable steels, such as armorplate.
	E.ER 308	18-8 or 19-9	0.08 max	19.0 min	9.0 min	.....	Dc Ac, Dc	-15 -16	Yellow Yellow	None None	Black Yellow	For Types 301, 302, 302B, 303, 304, 305 and 308. Also used to provide a protective overlay on iron alloy or steel surfaces.
	E.ER 308 ELC[5]	18-8 ELC	0.03 max	18.0-20.5	9.0-10.5	.....	Dc Ac, Dc	-15 -16	Brown Brown	None None	Black Yellow	For Type 304L stainless steels.
	E.ER 309	25-12	0.15 max	22.0 min	12.0 min	.....	Dc Ac, Dc	-15 -16	Black Black	None None	Black Yellow	For Type 309 stainless steels, stainless clad steels and hardenable steels where postheat treatments are not possible.
	E309 Cb	25-12 Cb	0.10 max	22.0 min	12.0 min	Cb=10×C min, 1.20 max	Dc Ac, Dc	-15 -16	Black Black	Blue Blue	Black Yellow	For Type 309Cb stainless steels and Type 347 stainless clad steels.
	E309 Mo	25-12 Mo	0.10 max	22.0 min	12.0 min	2.00-2.50 Mo	Dc	-15	Black	White	Black	For Type 309 Mo stainless steels.
	E.ER 310	25-20	0.20 max	25.0 min	20.0 min		Dc Ac, Dc	-15 -16	Red Red	None None	Black Yellow	For Type 310 stainless steels, stainless clad steels and hardenable steels where postheat treatments are not possible. To minimize crack sensitivity, a minimum carbon content of 0.09% in weld metal is desirable.
	E310 Cb	25-20 Cb	0.12 max	25.0 min	20.0 min	Cb=10×C min, 1.20 max	Dc	-15	Red	Blue	Black	For stabilized Type 310 stainless steels where extreme resistance to carbide precipitation is required, and for Type 347 stainless clad steels.
	E310 Mo	25-20 Mo	0.15 max	25.0 min	20.0 min	2.00-2.50 Mo	Dc	-15	Red	White	Black	For Type 310 Mo stainless steels, and for elevated-temperature applications where the added strength provided by Mo is desirable for Type 316 stainless clad steels. To minimize crack sensitivity, a minimum carbon content of 0.09% in weld metal is desirable.
	E312	29-9	0.08-0.15	28.0-31.0	8.5-10.5	.....	Dc	-15	Green	Red	Black	For "dissimilar-metal" joints on hardenable wrought and cast low and medium-alloy steels requiring weld metal of high yield strength and high ductility.
	E.ER 316	18-12 Mo	0.08 max	17.0 min	11.0 min	1.75-2.50 Mo	Dc Ac, Dc	-15 -16	Yellow Yellow	White White	Black Yellow	For Type 316 stainless steels.
	E.ER 316 ELC[5]	18-12 Mo ELC	0.03 max	17.0-19.0	12.0-14.0	1.75-2.50 Mo	Dc Ac, Dc	-15 -16	Brown Brown	White White	Black Yellow	For Type 316L stainless steels.
	E.ER 317	19-14 Mo	0.08 max	18.0 min	12.0 min	3.00-4.00 Mo	Dc Ac, Dc	-15 -16	Yellow Yellow	Brown Brown	Black Yellow	For Type 317 stainless steels.
	E318	18-12 Mo Cb	0.08 max	18.0 min	10.0 min	1.75-2.50 Mo Cb=10×C min, 1.20 max	Dc Ac, Dc	-15 -16	Yellow Yellow	Green Green	Black Yellow	For Type 316 Cb stainless steels and high alloy steels used at high temperatures where intergranular carbide precipitation is to be avoided.
	329	25-3 Mo	0.20 max	23.0-28.0	2.5-5.0	1.00-2.00 Mo	Dc	-15	Green	Yellow	Black	For Type 329 stainless steels.
	E.ER 330	15-35	0.25 max	14.0 min	33.0 min		Dc	-15	Green	None	Black	For Type 330 stainless steels and 15-35 (Cr-Ni) Type HT castings where welds require heat resistance up to 1900 F. To minimize crack sensitivity, a minimum carbon content of 0.18% in weld metal is desirable.
	E.ER 347	19-9 Cb	0.08 max	18.0 min	9.0 min	Cb-Ta=10×C min, 1.20 max; 0.08 max Si	Dc Ac, Dc	-15 -16	Yellow Yellow	Blue Blue	Black Yellow	For Type 347 and 321 stainless steels and where weldments may be exposed to service temperatures between 800 and 1500 F.
	348	19-9 Cb LTA	0.08 max	18.0 min	9.0 min	Cb-Ta=10× C min; 0.10 max Ta						For Type 348 stainless steels.

349	19-9 W Mo	0.07-0.13	18.0-21.0	8.0-9.5	1.25-1.75 W; 0.35-0.65 Mo; 0.75-1.25 Cb	Dc	-15	Yellow	Orange	Black	For high-alloy steels of similar composition exhibiting high creep strength at elevated temperatures.
	Stainless W	.....	0.07	17.0	2.0 Cb	Dc	-15				For stainless W.
	No. 20	20-29 Mo Cu	0.07 max	19.0-21.0	28.0-30.0	2.0-3.0 Mo; 3.5-4.5 Cu; 0.75-1.1 Cb	Dc	-15	Red	Brown	Black	For 20 Cr, 29 Ni, 3 Mo, 3 Cu stainless steels.
	Martensitic	E.ER 410	12 Cr	0.10 max	11.0-13.0	0.50 max	.....	Dc	-15	Gray	Brown	Black	For Types 403, 410 and 414. Preheat and postheat treatments are recommended.
		ER 420	12 Cr (C)	0.25-0.40	12.0-14.0	0.60 max	.....	Dc	-15				For Type 420 martensitic stainless steels.
	Ferritic	E.ER 430	16 Cr	0.10 max	15.5-17.0	0.50 max	.....	Dc	-15	Gray	Green	Black	For Types 405, 416, 430, 431 and 440. This grade is less air hardening than Type 410. The alloy is also used for facing valve seats. Preheat and postheat treatments are recommended.
		442	18 Cr	0.10 max	17.0-20.0	0.50 max	.....	Dc	-15	Gray	Red	Black	For Type 442 stainless steel. Preheat and postheat treatments are recommended.
		446	25 Cr	0.10 max	23.0-29.0	0.50 max	0.25 max N_2	Dc	-15	Gray	Yellow	Black	For Type 442 and 446 stainless steels. Preheat and postheat treatments are generally recommended.

[1] Prefix E signifies covered electrodes specified by AWS 5.4-53T and ASTM A298-53T (Reference 1). Prefix ER signifies bare electrodes and welding rods specified by AWS 5.9-53T and ASTM A371-53T (Reference 2).

[2] The 18-12, 19-9 and 19-14 grades are designated by many manufacturers as 18-8.

[3] Unless otherwise specified, other composition limits are: 2.5 max Mn, 0.75 max Si, and 0.030 max P and S.

[4] National Electrical Manufacturers Assn. *Standard for Arc-Welding Electrode Identification.*

[5] Extra-low-carbon grades designated as "ELC" on electrodes are the same as "L" designations used by AISI on wrought stainless steels.

for the wrought stainless steel grades.[2]

The prefix E (alone) in the *AWS-ASTM and Trade Designation* column denotes that the particular grade is recognized by the AWS-ASTM specification for covered electrodes; the prefix ER denotes that the particular grade is recognized by the AWS-ASTM specification for welding rods and bare electrodes. Where covered electrodes are required for shielded metal-arc welding, an electrode such as E308 or E347 should be specified. Where bare rods or wires are required as filler metal for welding with one of the inert-gas shielded processes or with the submerged-arc welding process, a bare wire or rod (cut wire) such as ER308 or ER347 should be specified, *Fig.* 1. The same wire may be used as electrode in automatic submerged-arc welding, *Fig.* 2; in manual or automatic inert-gas metal-arc (consumable) welding, *Figs.* 3 and 4; as welding wire in inert-gas tungsten-arc welding with separate mechanized wire feed, *Fig.* 5; or as welding rod (cut wire) in manual inert-gas tungsten-arc welding, *Fig.* 6.

Welding Characteristics: Certain alloying elements are not readily transferred from the electrode or welding rod to the weld-metal pool. Instead they may end up in the slag as oxides or other constituents or may be lost with the gases as metallic vapors. The amount lost depends upon the welding process, welding procedure, electrode diameter, and type of electrode or gas shielding. Titanium, for example, is readily oxidized. Since an oxidizing atmosphere is produced in shielded

Fig. 3—Manual inert-gas metal-arc (consumable) welding (automatic wire feed and manual torch) of stainless-steel frame for naval winch

metal-arc welding with covered electrodes, most of the titanium would not be transferred to the weld-metal pool, but would be lost by oxidation of the titanium. Thus, titanium-bearing (Type 321) electrodes would be unsuitable for the shielded metal-arc welding process. Consequently, they are not produced commercially. Type 321 stainless steel, therefore, is welded with columbium-bearing E347 electrodes.

Since the electrode and welding-rod manufacturer knows from tests and experience what alloy losses can be expected from various welding processes, procedures and stainless alloy compositions, he compensates for expected losses by an additional amount of alloying elements to make up for average expected losses. The additional alloying elements may be provided by the use of a special more highly alloyed core or filler wire, or by the addition of certain alloying elements to the electrode covering.

The user, therefore, is purchasing a weld deposit of a particular composition. For this reason, on covered electrodes, the chemical composition requirements of the applicable AWS-ASTM and government specifications pertain primarily to the deposited weld metal and not to the electrode core wire analysis. In the AWS-ASTM specification for welding rods and bare electrodes, on the other hand, chemical composition requirements pertain to the filler wire composition which, as a general rule, is very similar to that of the deposited weld metal.

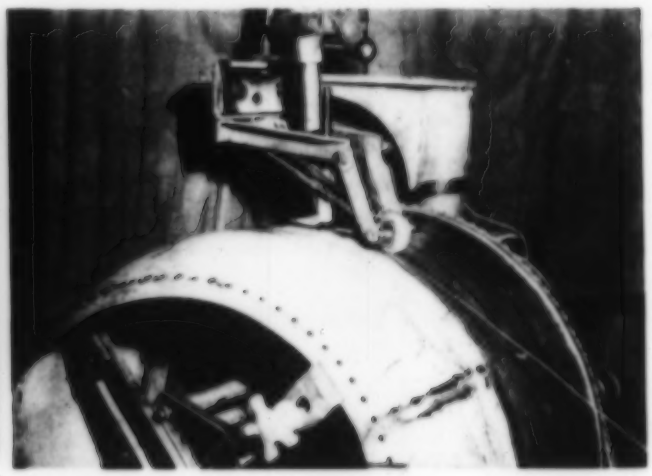
Table 2—Tensile Requirements and Typical Properties for All-Weld-Metal Deposits

AWS-ASTM Classification[1]	AWS-ASTM Minimum Tensile Requirements		Typical Average Test Results			
	Tensile Strength (1000 psi, min)	Elongation in 2 in. (%, min)	Yield Strength (1000 psi)	Tensile Strength (1000 psi)	Elongation in 2 in. (%)	Hardness (brinell)
E,ER 308	80	35	55	85	40-50	140-160
E,ER 308 ELC	75	35	52	80	35-45	.....
E,ER 309	80	35	57	88	35-45	150-175
E 309 Cb	80	30	68	92	30-40	.....
E 309 Mo	80	35	63	90	30-40	.....
E,ER 310	80	30	58	88	35-45	150-175
E 310 Cb	80	25	70	90	30-40	.....
E 310 Mo	80	30	60	90	30-40	.....
E 312	95	22	80	110	25-35	.....
E,ER 316	80	30	58	83	35-45	140-160
E,ER 316 ELC	75	30	55	80	35-45	.....
E,ER 317	80	30	70	95	35-45	140-160
E 318	80	25	67	90	35-45	.....
E,ER 330	75	25	50	85	30-40	165-190
E,ER 347	80	30	68	90	35-45	140-160
E,ER 410[2]	70	20	45	80	25-35	145-170
E,ER 430[3]	70	20	48	78	20-30	140-170

[1]See footnote 1, Table 1.
[2]Specimen shall be heated to between 1550 and 1600 F and held for 2 hr, furnace cooled at a rate not exceeding 100 F per hr to 1100 F, and air cooled.
[3]Specimen shall be heated to between 1400 and 1450 F and held for 4 hr, furnace cooled at a rate not exceeding 100 F per hr to 1100 F, and air cooled.

Fig. 4—Automatic inert-gas metal-arc (consumable) welding of seam welds in stainless - steel pipe

Fig. 5 — Inert-gas tungsten-arc welding of jet engine component with automatic wire feed arrangement laying filler wire in the groove ahead of the arc



Minimum tensile requirements of the AWS-ASTM specifications for covered electrodes and for welding rods and bare electrodes are the same for the various alloys covered. They are determined by so-called "all-weld-metal" tension tests. Minimum test requirements are listed in *Table* 2. Typical average test values are also included in this table.

Covered Electrodes: Most of the electrode covering types used on mild-steel electrodes (such as EXX10) are unsuitable for stainless-steel electrodes, because of the tendency of the weld metal to pick up carbon from these coverings. Only the mineral-type coverings, which do not contain cellulosic materials, are suitable for stainless-steel electrodes. Since they are of the same type as used on the so-called "low-hydrogen" EXX15 and EXX16 mild-steel and low-alloy steel electrodes, the -15 and -16 digits are also used to identify coverings on the stainless-steel electrodes.

The -15 and -16 classifications designate the "usability" of the electrode. The -15 covering types are intended primarily for welding with direct-current (reverse polarity), whereas the -16 types are suitable for welding with either direct current (reverse polarity) or with alternating current.

Table 3—Standard Sizes of Welding Rods and Bare Electrodes[1]

Form	Diameter (in.)	Tolerance (in.)
Welding rod in cut lengths	5/32, 7/64, 1/8, 9/64, 5/32, 3/16, 1/4	0.002
Welding rod[2] and electrode in coils	7/64, 1/8, 9/64, 5/32, 3/16, 7/64, 1/4	0.0015-0.002
Welding rod[2] and electrode wound on rims or spools	0.035, 0.045, 1/16, 5/64, 3/32	0.001

[1]From AWS-ASTM specifications, Reference 2.
[2]Out-of-roundness shall not exceed 0.001-in.

Fig. 6 — Manual inert-gas tungsten-arc welding of stainless-steel tubing assembly with filler metal supplied manually from straight lengths of welding rods

EXXX-15 Electrodes: Covering on these electrodes is also commonly referred to as a "lime"-type covering. It contains a large proportion of calcium or other alkaline earth minerals. Titanium compounds amount to less than 8 per cent. Because the slag formed is the least fluid and solidifies rapidly, these electrodes are preferred for welding in the vertical and overhead positions, though most commercial grades are also satisfactory for welding in the flat and horizontal positions.

EXXX-16 Electrodes: The very large majority of EXXX-16 stainless electrode types have "titania"-type coverings. These electrodes contain over 20 per cent of titanium-bearing minerals and ionizing elements such as potassium. A few of the EXXX-16 electrodes, particularly the E308 ELC and E316 ELC types, have so-called "lime-titania" type coverings containing higher proportions of lime than the "titania" types.

Oxidizing effect of the titania type covering provides a smoother, softer welding arc. Sputtering is minimized, and a greater arc stability desirable for alternating-current welding is obtained due to the presence of the ionizing elements. The more fluid slag flows rapidly to the back half of the puddle, has very little tendency to interfere with the welding operation, and makes greater welding speeds possible. The slag, when cooled, is hard and glossy.

Welding Rods and Bare Electrodes: Welding rods and bare electrodes are available in straight lengths and coils, and wound on rims and spools. Standard sizes are listed in *Table* 3. Standard lengths of cut welding rods (i.e., straightened wire) are 36 inches.

Straight lengths are usually used as welding rods for manual inert-gas tungsten-arc welding. Wire coils generally are used as electrodes for submerged-arc welding. Wire spools generally are preferred as electrodes for inert-gas metal-arc (consumable) welding and as welding rods for inert-gas tungsten-arc (nonconsumable) welding.

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2. *Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes*, ASTM specification A371-53T; AWS specification A5.9-53T.

PHOTO CREDITS

Figs. 2 through 5 have been supplied by courtesy of Linde Air Products Co.; *Fig.* 6 through courtesy of American Iron and Steel Institute.

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This article is the fifth in a co-ordinated group of articles by Helmut Thielsch on welding and weldments. Previous articles, and issues of MACHINE DESIGN in which they appeared, are:

Wrought Carbon and Alloy Steel: Weldability ..... May, 1955
Weldability of Stainless Steel ..... June, 1955
Weldability of Cast Steels ..... July, 1955
Selecting Electrodes and Welding Rods:
Part 1—Mild and Low-Alloy Steels ..... September, 1955

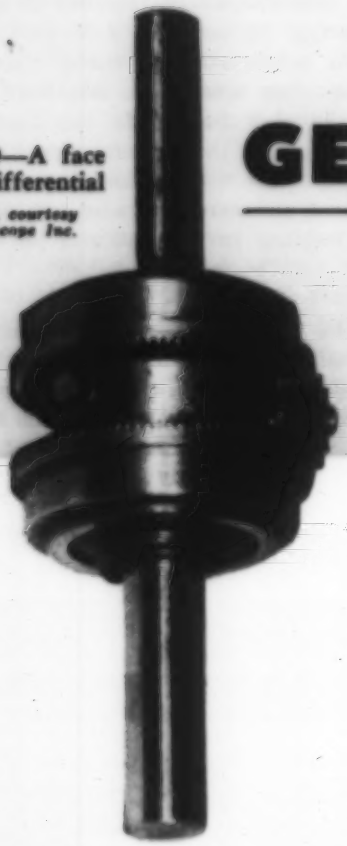

Fig. 19—A face gear differential

Photo, courtesy Librascope Inc.

GEAR DIFFERENTIALS

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DEFINITION, analysis, types and applications of gear differentials have been covered in Part 1 (October) of this two-part article. Discussions of the practical aspects of gear differentials are presented in this concluding part, with particular emphasis upon factors involved in instrumentation applications.

Common differential designs used in the majority are of either the bevel gear or spur gear types. Other varieties are of much more limited application and used only in special cases. As an example of a possible variation, the gears can be designed as face gear pairs, *Fig.* 19.

Bevel and spur gear differentials function identically but their physical designs are considerably different, warranting a critical comparison. This is of particular value in connection with precision applications such as in servomechanisms and computers where the most accurate differential type is desired, assuming cost and other considerations to be equal. Therefore, it will be of value to evaluate tersely the two most prevalent types of differentials, *Table* 1. Although this evaluation is brief, it is intended to be of assistance to both the designer and user of differentials in establishing general design, fabrication, and functional features and limitations.

Differential functioning errors must be considered in the satisfactory application of differentials to precision mechanisms. There are two fundamental errors affecting their precision: Backlash and angular inaccuracy of transmission.

These errors† exist in all gear trains but, for the diffential, they are somewhat unusual because of their interrelation when attempting to reduce them to minimums.

Backlash of a differential is defined as the angular motion between the end gears when one of them and the spider shaft are held fixed and the other is rotated between its extreme positions clockwise and counter-clockwise. The measurement is for some specified loading upon the free end gear. The total backlash is the accumulation of error due to tooth thinning, bearing and shaft looseness, and pitch circle runout. In addition, for bevel gear differentials, there is some backlash due to human error at assembly, and for spur gear differentials some backlash will be introduced because of the tolerance on the boring of gear centers.

For bevel gear differentials, the total backlash is the sum of backlash between the spider gear and the two end bevel gears, *Fig.* 1, *Part* 1, if it is assumed there is some backlash between each contact of the cylinder. Then, obviously, plane B can be moved a linear amount equivalent to the sum of backlash at the two contacts before the center O begins to be displaced. This same reasoning can be extended to *Fig.* 3, *Part* 1, which shows the essentials of a bevel gear differential and where the two sources of backlash are M_1 and M_2.

Spur gear differentials have an additional gear mesh because of the spider gear (gear C) being split in two and meshed together. Therefore, the backlash between end gears is the sum of backlash for the three gear meshes: M_1, M_2, and M_3 in *Fig.* 7, *Part* 1.

The minimum possible angular backlash is re-

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†G. W. Michalec—"Precision Gearing," MACHINE DESIGN, Jan. 1955, Pages 154-163; Feb., Pages 200-209; Mar., Pages 174-180; April, Pages 201-208.

Part 2

COMMON DESIGNS
FUNCTIONING ERRORS
TESTING
PRACTICAL DESIGN FACTORS
COMMERCIALLY AVAILABLE UNITS

Table 1—Comparison of Gear Differentials

Bevel Gear Differentials	Spur Gear Differentials
Advantages	
1. Bevel gears can be adjusted axially to remove backlash. Nominally speaking, they can be adjusted to give zero backlash.	1. Spur gears are the most common type and easiest to procure.
2. A bevel gear unit is compact and small since the pinion bevels are almost essentially within the outside diameter of the large end bevels. The spider pinions can be made large in diameter without directly increasing the working diameter of the unit.	2. Spur gears can be made more accurate than any other type of gear.
3. The inputs and outputs are conveniently arranged.	3. Spur gears can be more accurately inspected.
4. The total backlash is the sum of backlash of only two basic meshes: M_1 and M_2 in *Fig.* 3, *Part* 1 (October 1955).	4. There is the possibility of at least partially spring-loading the gear meshes of this type of differential.
	5. The assembly is clean-cut, being free of many of the variables of bevel gear assemblies such as shimming and deflections due to end thrust.
	6. Designs along the line shown in *Fig.* 15b, *Part* 1, allow for greater take-off end gear versatility than for bevel gear differentials which usually have their spur end gear take-offs staked or otherwise permanently fastened to the end bevel gears.
Disadvantages	
1. Bevel gears are more difficult to produce than other types of gears. They require special generating equipment and more know-how for machine setup.	1. In many designs the spider take-off is more complex and bulky than for bevel differential.
2. Bevel gears are not the most accurate type of gear. They cannot be as accurately inspected as spur gears.	2. Spur gears require the accurate boring of centers as contrasted with no boring at all for bevel differential. Also the backlash cannot be adjusted because the gear centers are bored and fixed.
3. Adjustment of bevel gears axially to remove backlash is contrary to maintaining true conjugate gear action. Bevels are of octoid tooth form approximating a spherical involute. Proper adjustment to eliminate backlash would be axis rotation, but this, of course, is impractical. Therefore, the practice of axial shift to eliminate one malfunction creates another which can be severe if the shift is great.	3. The total backlash is the sum of backlash of three basic meshes as contrasted with only two for the bevel gear differential. The three meshes are shown in *Fig.* 7, *Part*, 1, as M_1, M_2 and M_3.
4. End thrust of bevels is undesirable.	4. Increase of the diameters of the spider pinions directly increases the working diameter of the unit.
5. Precision bevel gears are not interchangeable but are made in matched pairs—a limitation on complete interchangeability.	

lated to the size of the differential. The larger the gear components, the smaller the angular backlash. However, with the growing tendency to miniaturize equipment, size and accuracy must often be compromised. As an example, typical small precision differentials used in computers have working diameters of 1 to 1¼ inches and a maximum backlash specification from 15 to 10 minutes of arc, respectively, for a loading in the range of 4 to 6 oz-in. More will be said about sizes and backlashes with respect to commercially available differentials.

Inaccuracy of transmission is due to a net pitch circle runout and tooth-to-tooth composite error. The tooth composite error is inherent to the gear once it is cut. The pitch circle runout is a vector sum of installation eccentricities and gear generating runout. A detailed analysis of these error sources is omitted from this article since it has been covered in the cited reference. It merely suffices to point out that the existence of some error in the pitch circle results in nonlinear transmission of velocity and therefore error in position. The result is the output of the differential varies slightly relative to the input. That is, within whole rotations, the output will not be equal to the input. This is objectionable for precision applications and therefore must be controlled. Moreover, any eccentricity in gear rotation requires the mesh to be set up for the tightest point. Therefore, the backlash is increased when the low points of mesh come into contact. Thus, the minimum angular backlash can be no less than the angular inaccuracy error of the differential.

The foregoing facts are strictly true when the differential has only one spider gear (gear *C*). Differentials are often constructed with two spider gears for dynamic balance. For such a case, there must be sufficient backlash to absorb the worst additive combination of inaccuracy error due to the two spider meshes, because the spider gears operate on a common shaft and must necessarily rotate together at all times. Therefore, local error in the pitch circle of either the spider gear or the meshing end gears may cause the spider gear either to speed up or to slow down. Since the error source may be at only one of the spider meshes, the other must have space or backlash to absorb the small error of displacement. Also, errors between the spider gears and the same end gear may be at their peak values simultaneously, but of opposite sense. This condition would require sufficient backlash of the spider meshes to absorb the total inaccuracy of transmission. Thus, the result of multiple spider gears is that the possible minimum backlash is increased. Theoretically, therefore, a slightly more accurate differential can be made if one spider mesh is used.

Testing differentials for the three parameters—backlash, inaccuracy of transmission, and internal friction—is of vital importance for precision applications.

Backlash testing is relatively easy in the more usual type of gear train since it consists mostly of component sources fixed in value with gear rotation. However, in precision differentials, the backlash goal is so low that components variable with gear rotation are of significance. Therefore, the backlash should be measured for a series of points

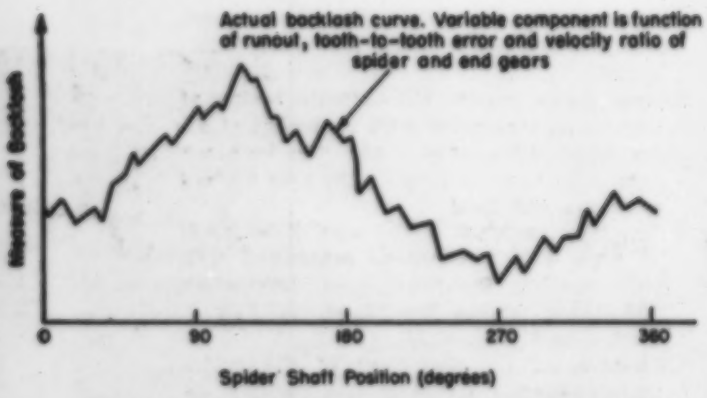


Fig. 20—Above—Backlash curve for a differential

Fig. 21—Right—Fixture for measuring backlash of a differential at specified torque values

Photo, courtesy Librascope Inc.

as the differential is rotated. Ideally, it would be desirable to measure backlash for every gear phase and plot the results as a continuous curve such as shown in *Fig.* 20. Then, it is certain the maximum backlash point would be obtained, whereas the maximum backlash may not be measured if only spot check points are used.

Of major importance is to specify backlash and test for it at some specified loading which, of course, depends upon the application. If backlash is measured as the load is increased, a so-called gear train hysteresis loop can be determined. This curve integrates true backlash as well as friction and strain due to loading.

A number of ingenious test fixtures can be used to accomplish backlash measurement. Although it is not the purpose of this article to analyze them, *Fig.* 21 shows an actual practical test jig for measuring differential backlash. Note the use of a sensitive indicator and the application of a known spring force to make the backlash measurement for a specific applied torque.

Inaccuracy testing can best be performed by magnifying the output of the end gears with known accurate gears. Sometimes it is possible to do this directly on the end gears. Direct-reading dials, optical methods, and electrical means of measuring angles can be used. It is important to use a calibrated input, such as a high quality dividing head or precision synchro. *Fig.* 22 shows a schematic arrangement for measuring inaccuracy with a dividing head input, calibrated dial output and optical means for reading outputs. Again, since inaccuracy varies with position, many points must be measured throughout complete rotation of the differential. When the accurate input to the differential is accomplished through the use of couplings or a gear mesh, it is important that these components do not introduce any appreciable error. Hence the gears of a gear input mesh must be both larger and more precise than those in the differential. A coupling must have no transmission error and preferably be free of backlash. In *Fig.* 22 a bellows type instrument coupling is shown, since this device has neither type of error when properly designed and applied.

Internal friction testing is advisable because the differential is prevalently used in low-torque systems. For instance, the outputs of mechanical ball and disk integrators often drive differentials. Since these devices usually have output torques of merely an ounce-inch or two, and even less for maintenance of maximum accuracy, the torque loading of the differential can be critical.

A low-torque differential requires quality bearings, precise gearing, minimum dimensions for small radii of operation of the friction forces, and proper lubrication. To achieve low friction torque at room-ambient operation is difficult enough, but it is relatively easy in comparison to a temperature range of +71 C to −65 C which is sometimes specified in military designs. In such cases, the various factors become critical, particularly lubrication.

The testing for and measuring of internal friction is not a simple matter because of the small torques involved. Various test procedures and jigs have been designed and there probably is no one universal system highly superior to all others. As an example, *Fig.* 23 shows a fixture for this purpose. Internal differential friction is measured as the reaction force of one fixed input. This fixture is in effect an application of the principle shown schematically in *Fig.* 2.2,*Part* 1. Also, because friction being measured is very small, the additional load due to the fixture bearing is undesirable and must be controlled to a negligible value. Therefore, the pendulous principle shown in *Fig.* 2.3,

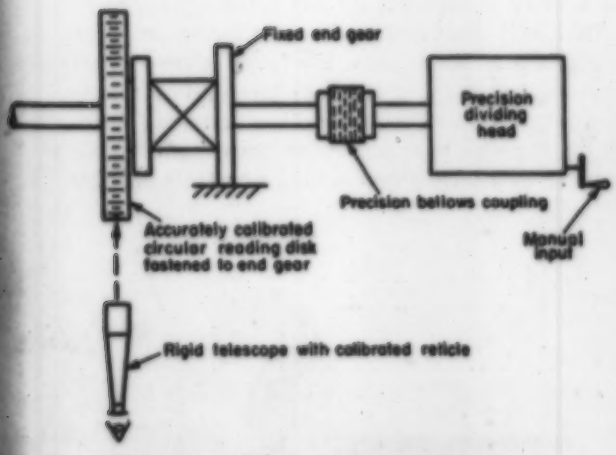

Fixed end gear
Precision dividing head
Precision bellows coupling
Accurately calibrated circular reading disk fastened to end gear
Manual input
Rigid telescope with calibrated reticle

Fig. 22—Above—Arrangement for measuring inaccuracy between the spider shaft and one of the end gears

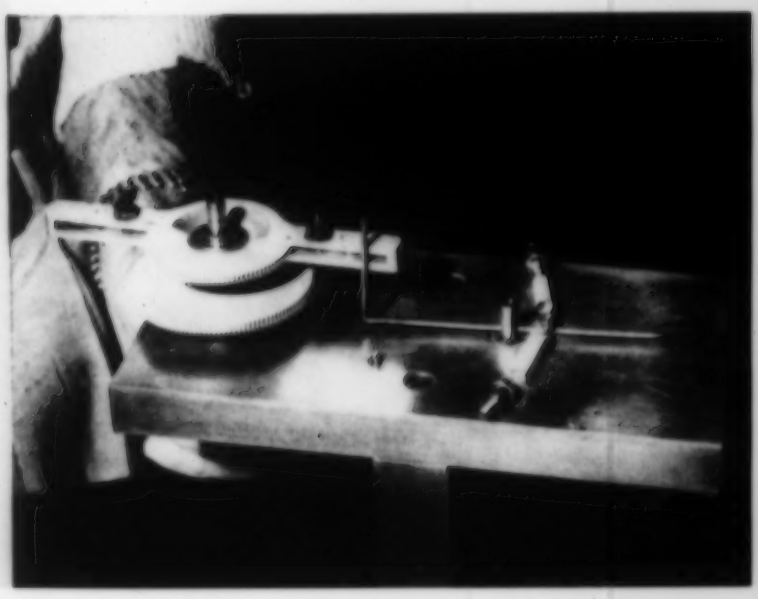


Fig. 23—Right—Fixture for measuring internal friction torque of a differential

Photo, courtesy Librascope Inc.

Part 1, could be used advantageously in this case.

Practical design considerations for a differential depend upon the application. Obviously, the requirements and considerations for an automobile rear-end differential differ radically from those for computer applications. The latter would probably be designed from the viewpoint of maximum accuracy, minimum size, and minimum friction, whereas the former would be designed for high torque, speed and life. However, there are a number of general design considerations which are worthy of comment.

First, there is the choice of basic differential type: bevel versus spur gear differential. In some special cases the choice will be broader, including internal and other special designs. However, normally, design needs are conventional and the choice is between the bevel and spur types. This decision will be influenced by the items listed in *Table* 1 and their relative importances.

The next design consideration is the size of the differential. The criterion for this is the working diameter of the unit. The working diameter is defined as the swing of the spider assembly as illustrated in *Fig.* 24. Note this does not include the end gears. The working diameter is an important criterion for it determines the form and limitations of designing the differential into a package with other items.

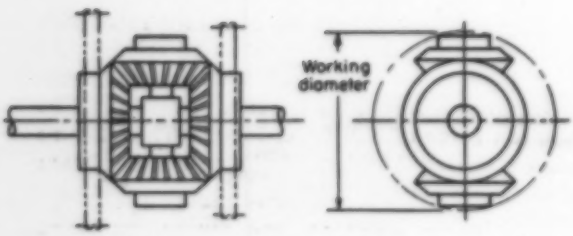
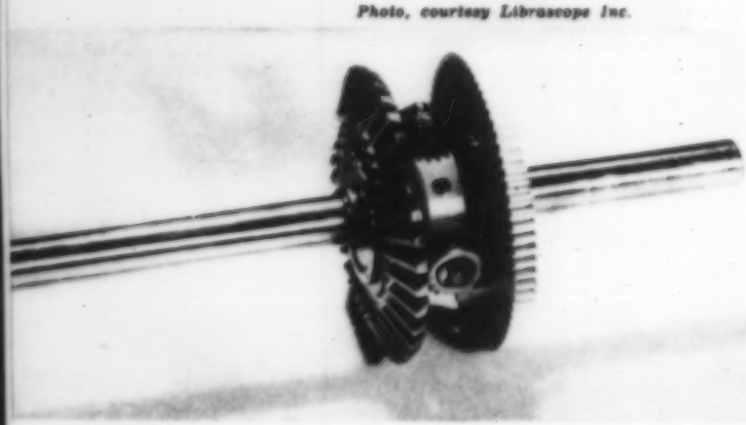
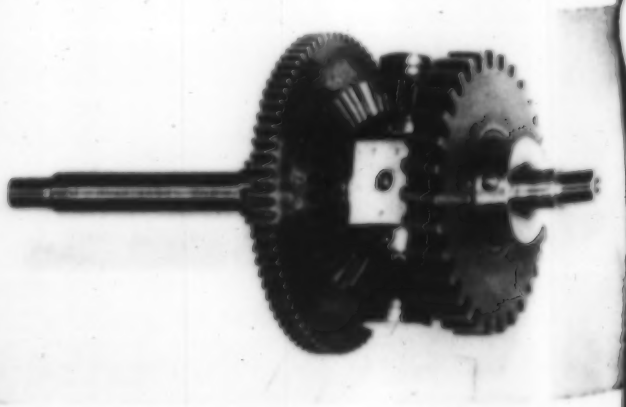


Fig. 24—Above—Definition of the working diameter of a differential

Fig. 25—Below—Left, differential with a take-off bevel gear cut integral with the end bevel gear and, right, one with a helical take-off end gear

Photo, courtesy Librascope Inc.





For a given working diameter, the other elements must be consistent in design. That is, fixing the working diameter limits the gear diameters which, in conjunction with load rating, influence the choice of pitch. Similarly, the shaft diameters and in particular the main spider shaft will be influenced by the desired overall size. Naturally, the smaller the unit the finer the gear pitch and the smaller all elements such as gears, shafts, bearings, etc. Since the spider shaft diameter is somewhat related to the working diameter (by the influence on related elements) it is often used as the criterion for size, and differentials are sometimes labeled by the shaft diameter, such as: 3/16-inch differential, ¼-inch differential, etc.

In the design of differential gears, careful consideration must be given to the required quality. The more rigid the quality in terms of total composite error, tooth-to-tooth composite error and tooth thickness, the lower the differential backlash, inaccuracy and friction. For example, for the most precise applications the gears would be designed much in accordance with AGMA class precision 3-C (Spec. 236.03). In addition, care must be taken to insure good fits free of looseness between gear bores and their mounting diameters. Otherwise, the expensive precision cut into the gear teeth would be useless.

For bevel gear differentials, there is a choice of type of bevel gear: straight, Zerol or spiral. If high load and speed are not factors, and they usually are not in instrument applications, there is little choice. The decision usually involves considerations such as available type of bevel gear generating equipment and which type gear the shop can produce most affectively. Excellent bevel gear differentials have been produced with all three types, as shown by various photographs in this article.

A further consideration is that of the bearings, which will be influenced by the intended speed of operation and the desire for minimum friction. Ball bearings predominate, but good sleeve bearings are satisfactory in small differentials for low-speed applications. To obtain differentials of maximum quality the bearings must be of comparable quality. Precision instrument differentials require

ball bearings of quality ABEC-5 or 7, with radial and axial loosenesses controlled within a few ten thousandths. Furthermore, the fit of the shafts and bearing bores must be equally good. Selective assembly is usually necessary.

To obtain maximum precision all the differential elements must be of the highest quality. This means not only the gears, bearings and shafts, but also shims, spacers, collars, retainers, etc. Also, the machining and assembly work, such as squareness of elements and pinning operations, must be consistently good. All these items are important because they have direct influence on differential backlash and inaccuracy.

A related consideration is the gear material. For power applications it is necessary to consider steels and, in the extreme high-load cases, the best hardenable alloy gear steels are used. However, for instrument applications, where there will be no reliable lubrication, or possibly none at all, the materials are selected for other considerations such as minimum wear and friction, ease of cutting to achieve maximum precision, minimum weight, noncorrosiveness, etc. Thus, instrument differentials are designed with such combinations of gear materials as low carbon steels and bronzes, stainless steels and bronzes, stainless steels and aluminum alloys.

A further design consideration is that of the take-off end gears. Usually these will be determined design-wise by the packaging into the exact application. That is, the differential take-off end gears are integrated into the gear train. Thus, their size and pitch will vary with the application. Although end gear take-offs are usually spur gears, sometimes they can be very special. In *Fig.* 25 a bevel gear take-off is shown. In this example the differential end bevel gear and the take-off end bevel gear have been designed integral. Another special example, a helical gear take-off, is shown in *Fig.* 25.

Similarly, the differential spider shaft is often designed to fit closely into the exact application and so results in a much more efficient and consistent overall design. Thus, the spider shaft length, diameter and any further special features will be influenced by its incorporation into a specific gear train.

It should be realized that regardless of the possible special variations in take-off end gear and spider shaft designs, the internal parts or heart of the differential unit can be common throughout a vast series of designs. This would include the differential end gears, spider gears and spider housing assembly, but not the take-off end gears.

One important design consideration which was mentioned briefly in previous sections is the number of spider gears. This number can be one or more, but as can be seen from the various photographs most units are made with two sets of spider gears. Although static and dynamic balance plus greater load rating are thereby provided, difficulties in attempting to achieve ultraprecision may be encountered. More than two spider gears are not commonly used except where there is insufficient bearing stability. Such cases occur in bevel gear differential designs when the end gears are mounted in a single ball bearing. Then, to limit the bearing looseness, three or more equally spaced spider gears are used. Examples of three-spider gear differential designs are shown in *Figs.* 19 and 26.

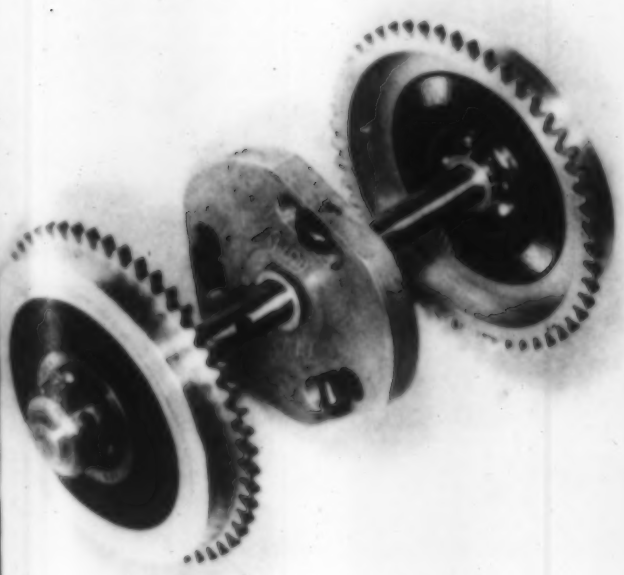


Fig. 26—Exploded view of a light-duty compact differential employing three spider gears to augment bearing stability

Commercial stock differentials are available even though the differential is not a highly standardized component. This is so because of a number of practical reasons. First, differentials are used over a wide variety of applications—from small watch-like mechanisms to power gear trains such as those in the rear-end drives of trucks. Obviously, even though such differentials function identically, the extremes in physical dimensions require individual design.

Even in a single field of application, such as mechanical and electromechanical computers, the requirements vary considerably. Often, desire for compact design will require close and congruent design into a special gear train, such as the differentials shown in *Fig.* 25.

However, despite variations in design dictated by application, there is some standardization based upon common internal parts (differential end gears and spider gears, spider housing, shafting, bearings and assembly). This limited standardization is, of course, confined to a general field of applications. Within the limitations of fields of applica-

tion and standard internal parts, a number of manufacturers have developed lines of commercially available stock differentials. However, this standardization is very much limited to the fields of instrumentation.

It should be borne in mind that to have stock differentials certain design feature versatility must be sacrificed. Thus, spider shaft diameters and working diameters are fixed. Also, the precision of the unit in terms of backlash will be set by the manufacturer. However, to allow for some versatility the units are stocked and sold without end take-off gears, left for the customer to determine, or else they are included according to customers' requirements.

A partial review of commercially available differentials may be helpful. *Table* 2 is a brief listing of differential manufacturers and pertinent information for a number of stock differentials. Design details of typical units are shown in *Fig.* 27.

In *Table* 2 the spur-type is noticeably in the minority. There is one listing of spur differentials, which is additionally unique in that the units range from light instrument applications to large power

Fig. 27—Typical commercially available stock differentials

devices of 2½-hp rating.

The hollow spider shaft differentials offer a unique feature. By means of the through shaft bore, in many applications the unit can be conveniently installed and removed from the assembly without disrupting other portions of the assembly.

For the units listed in *Table* 2 prices range approximately from $65.00 to $130.00 for the basic bevel gear type differentials plus $10.00 to $20.00 for take-off end gears. The spur models vary from approximately $33.00 to $195.00 depending upon size.

The bevel gear type predominates in *Table* 2. However, this impression of predominance is offset to some extent when all differential manufacture is considered. Since differentials are of special design and often are closely integrated into the application, there are many differentials produced as parts of larger devices. Thus, the overall production of differentials is much larger than that implied by the list of commercial sources, and many not mentioned here are of the spur gear design.

An important fact revealed in *Table* 2 is that the typical backlash figure is around 10 minutes of arc, which is considerably better than the electrical differential synchro which is sometimes a substitute. Currently the accuracy of these electrical differentials is in the order of 30 minutes.

Future trend will be design and construction of precision units of smaller dimensions paralleling the growing miniaturization occurring within the instrumentation field. However, producing smaller units, with the current degree of high accuracy will depend upon success in cutting more precise gears and related parts.

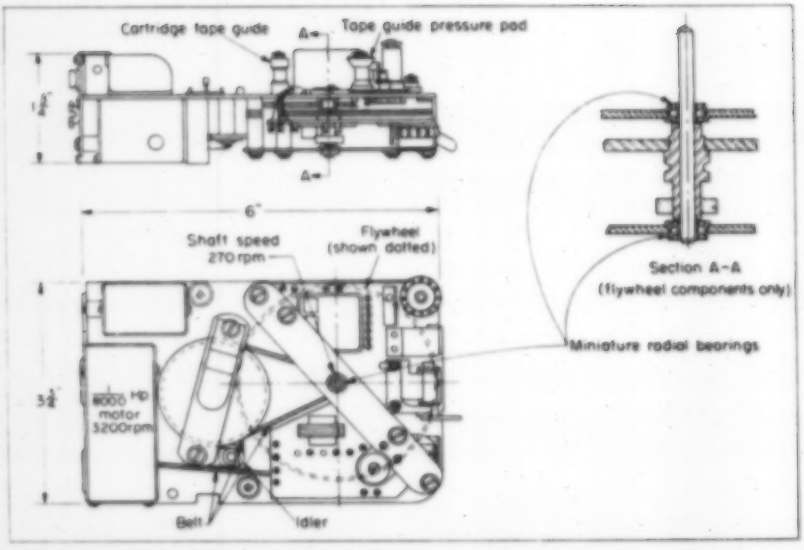
Table 2—Commercially Available Gear Differentials

Manufacturer	Type	Nom. Spider Shaft Diam. (inches)	Working Diam. (inches)	Max. Backlash between End Gears (minutes of arc)	Max. Load Rating (oz-in.)	Speed Rating of End Gears (max rpm)	Bearings	Notes
Arma Corp. Garden City, N. Y.	Bevel	1/2	2 1/2	6, 12 or 24			Ball	
		5/8	2 1/2	6.5, 13 or 26				
		1/2	2 1/2	5.5, 11 or 22				
		5/8	2 1/2	4.5, 9 or 18				
		1/2	3 1/2	4.3, 8.5 or 17				
		5/8	3 1/2	3.5, 7 or 14				
Belock Instrument Corp. (*Fig.* 27a, b) College Point, N. Y.	Bevel	1/2	1 1/4	18	12	600	Sleeve	
		5/8	1 1/2	14	45	600		
		1/2	1 1/2	10-6	100	1500	Ball	
		3/4	2	10-6	150	1800		
		1/2 or 5/8	1 1/2	10-6	90	1800		
Ford Instrument Co. (*Fig.* 27c, d) Long Island City, N. Y.	Bevel	1/2	1.00	12		550	Ball	
		1/2	1.39	7		500		
		1/2	2.06	5		800		
		1/2	2.40	5		800		
Instrumentool Co. (*Fig.* 27e) New York, N. Y.	Bevel	1/2	1.02	10 at 3 oz-in.			Ball	
		1/2	1.02					
Librascope Inc. (*Fig.* 27f) Glendale, Calif.	Bevel	Hollow shaft 1/2 bore	1.090	10 at 3 oz-in.		800	Ball	
Link Aviation Inc. (*Fig.* 27g) Binghamton, N. Y.	Spur	Hollow shaft 1/4 bore	2 3/4	15	96	600	Ball and sleeve	
Milwaukee Lock & Mfg. Co. (*Fig.* 27h) Milwaukee, Wis.	Spur	1/4	1.30	1 deg	25	3000	Sleeve	
		1/2	2.67		100	3000		
		1/2	2.25		1/3 hp	1500		
		5/8	3.60		2 hp	1800		
PIC Design Corp. (*Fig.* 27i) Lynbrook, N. Y.	Bevel	1/4	1 1/2	10	45	600	Ball	1
		1/2	1 1/2		100	1800		1
		1/4	1 1/2		150	1800		1
Pitometer Log Corp. (*Fig.* 27j) New York, N. Y.	Spur	1/4	1 1/4	Not specified	2(tentative)	1000(tentative)	Ball and sleeve	
	Bevel	1/2	1 1/2	Not specified	100	1500	Ball	2
Reeves Instrument Corp. (*Fig.* 27k, l, m) New York, N. Y.	Bevel	1/4	1.375	12 or 7	24	2500	Ball	
		1/4	2.093	12 or 5	100	1500		
		Hollow shaft 1/4 bore	1.932	7 or 3	24	2500		2
		Hollow shaft 1/2 bore	1.932	7 or 3	24	2500		2
Reflectone Corp. (*Fig.* 27n) Stamford, Conn.	Bevel	1/2	1.360	14	6	500	Ball	
Sterling Precision Instrument Corp. (*Fig.* 27o, p) Flushing, N. Y.	Bevel	Hollow shaft 1/2 bore	0.600	0-20(adjustable)	7	700	Ball	
		Hollow shaft 1/4 bore	0.750	0-20	10	700		
		Hollow shaft 3/8 bore	1.000	0-20	12	900		
		Hollow shaft 1/4 bore	1.187	0-20	15	900		
		1/8, 1/4, 3/8 shaft diameters	1.750	0-20	40	1000		3

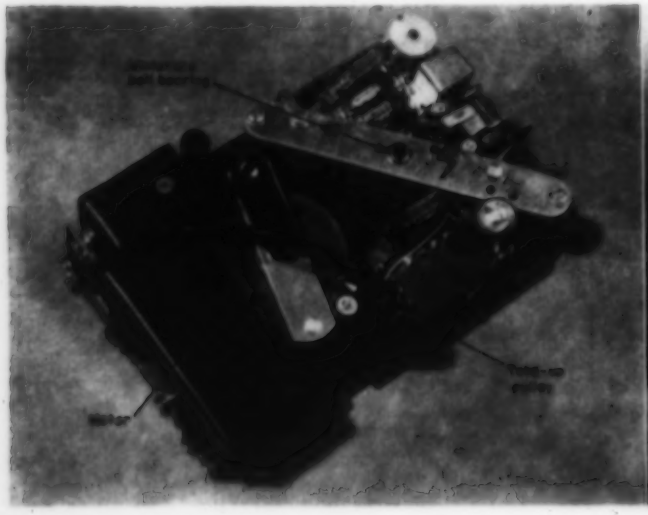
Notes:
1. Take-off end gears removable, adjustable counter balance.
2. Take-off end gears removable.
3. Encased unit with input and output shafts concentric and on one end.

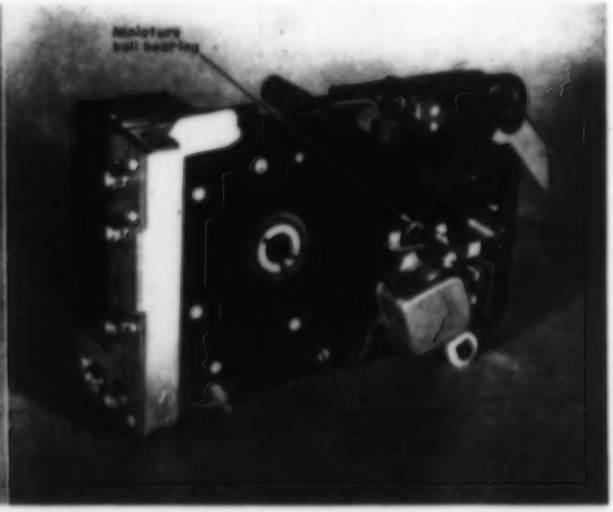
Portable Tape Recorder

A recently-introduced, battery-operated portable tape recorder will operate for 45 hours on one set of hearing-aid batteries. Only 1⅞ in. deep, 3⅞ in. wide and 8½ in. long the recorder weighs 3¼ lb. A removable tape cartridge contains enough tape for one hour of recording. The cartridge contains two reels which revolve independently on the same axis. Tape emerges through a slot from one reel and reenters the cartridge through another slot to be taken up by the second reel. Either side of the cartridge may be placed down on the drive spindle which automatically engages the lower reel with the take-up mechanism. This arrangement utilizes two halves of the tape to make dual track recordings. A window in the cartridge permits the user to see how much tape remains. An additional feature is an indicator light that goes off when only two hours of recording time is left in the batteries.



Governor-controlled, the 1/8000-hp motor is coupled by a spring belt to a flywheel having a pulley groove around its perimeter. The belt-driven flywheel is mounted on the main shaft. Use of two miniature, flanged radial-retainer type ball bearings on the main shaft is largely responsible for the long battery life. The 0.3125-in. OD, 0.1250-in. bore bearings are made by Miniature Precision Bearings Inc. Tape is driven by the main shaft. A pinch roller is used to hold the tape in contact with the shaft. A second spring belt connects the main shaft to the take-up reel shaft.





Characteristics of

Investment Casting Alloys

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INVESTMENT castings offer a number of design advantages. Perhaps the most important is the cost-reduction possibilities on intricate parts. No less important is the fact that this process permits a wide selection of alloys; it is possible to use any one of over 250 alloys depending on the design and application requirements involved. Ratings of castability of approximately 100 representative alloys are given in *Table* 1. Detailed information on the properties of 26 typical investment casting alloys make up the contents of *Table* 2.

Another valuable attribute of using the investment-casting technique is design versatility. Suited for both experimentation and high production, the process permits making parts that may be essentially impossible to machine or fabricate. For example, some alloys which cannot be machined or forged can be shaped by the investment casting method.

Table 1—Castability Ratings of Investment Casting Alloys

Low Alloy Steels

Excellent Castability
52100 (mod)

Good Castability
3140 (mod)
4130 (mod)
4140 (mod)
4142 (mod)
4150 (mod)
4340 (mod)
4640 (mod)
6150 (mod)
8640 (mod)
8730 (mod)
8740 (mod)
8750 (mod)
9310 (mod)

Fair Castability
1030 (mod)
1035 (mod)
1040 (mod)
1050 (mod)
1060 (mod)
1095 (mod)
4615 (mod)
4620 (mod)
8615 (mod)
8620 (mod)

Poor Castability
1020 (mod)
1025 (mod)

Tool Steels

Excellent Castability
Airkool
Crucible Airdi-150

Good Castability
Carpenter KW
Carpenter RDS
Carpenter Solar
Crucible Ketos
Crucible Rex-AAA
HY-3C
PRK 33
Rex-Alloy
Seminole Med.

Fair Castability
Rex-AA
Red Cut Cobalt
Star Zenith

Stainless Steels

Excellent Castability
Armco 17-4 PH
Type 302
Type 304
Type 310
Type 316
Type 347

Good Castability
Type 309
Type 430
Type 431
Type 436
Type 440A
Type 440B
Type 440C

Fair Castability
Type 420

Poor Castability
Type 410

Nickel Alloys

Good Castability
Cast Monel
Beryllium nickel 260-C
S Monel

Fair Castability
Electric 4750 alloy
Inconel
Invar

Copper-Base Alloys

Excellent Castability
Beryllium copper 20-C
Beryllium copper 275-C
Silicon brass, B198-13B
Silicon bronze B198-12A

Good Castability
Beryllium copper 55-C
Navy "G" bronze, B143-1A
Phosphor gear bronze

Fair Castability
Aluminum bronze A, B
Aluminum nickel bronze, AMS-4640
Leaded red brass 85-5-5-5
Manganese bronze A, B, C

Poor Castability
Leaded yellow brass

Aluminum Alloys

Excellent Castability
Type 355
Type 356

Fair Castability
40-E
Tern alloy No. 7

Poor Castability
B195-A
No. 132
No. 214
No. 612

Special Alloys

Excellent Castability
Colmonoy No. 4
Colmonoy No. 6
Stellite No. 6
Stellite No. 21
Stellite No. 31
Stellite No. 90
Stellite No. 92
Stellite No. 93

Good Castability
Hastelloy B
Hastelloy C
Hastelloy X
High-silicon iron
Ni-Resist 1A
Timken 17-22A alloy

Fair Castability
Heppenstall Pres-Tem
Minovar

Poor Castability
Armco Iron
Nitralloy No. 135

Table 2—Characteristics of Investment Casting Alloys

	Low Alloy Steels				Tool Steels				Stainless
	4620 Mod	4140 Mod	6150 Mod	52100 Mod	Water Hardening (Carpenters Solar)	Oil Hardening (Crucibles Ketos)	Air Hardening (Crucibles Airdi—150)	High-Speed (Crucibles Rex—AAA)	Precip. Hardening (Armco 17-4 PH)
AS CAST									
Tensile Strength psi	96,000	132,200	115,500	110,000	100,000	145,000	107,000	———	107,000
Yield Strength psi	59,000	117,200	91,400	108,000	68,000	118,000	86,000	———	87,000
% Elongation in 1 in.	14.0	4.5	2.5	1.0	18.0	1.0	1.5	———	1.0
Hardness	Rb 85-95	Rc 28-32	Rc 25-28	Rc 24-27	Rc 20-22	Rc 39-42	Rc 35-38	Rc 45-55	Rc 38-41
ANNEALED									
Tensile Strength psi	90,700	117,200	102,000	101,000	98,000	110,000	88,900	———	159,500
Yield Strength psi	41,500	69,200	58,000	68,000	60,000	73,200	58,600	———	68,700
% Elongation in 1 in.	20.0	19.0	16.0	18.0	17.0	17.0	2.0	———	5.0
Hardness	Rb 88-92	Rb 94-99	Rb 90-95	Rb 90-95	Rb 90-98	Rb 90-94	Rc 25-29	Rc 25 min	Rc 36 max
HEAT TREATED									
Tensile Strength psi	130,000	155,000	225,000	———	———	———	———	———	180,000
Yield Strength psi	110,000	142,000	200,000	———	———	———	———	———	115,000
% Elongation in 1 in.	15.0	9.0	———	———	———	———	———	———	3.0
Hardness	Rc 26-30	Rc 33-36	Rc 62 max	Rc 63 max	Rc 63 max	Rc 63 max	Rc 63 max	Rc 66 max	Rc 40-45
Castability	Fair	Good	Good	Excel	Good	Good	Excel	Good	Excel
Machinability[1]	65A	60A	45A	35A	50A	30A	25A	30A	65A
Weldability	Good[2]	Good[2]	Good[2]	Good[2]	Good[2]	Fair[2]	Poor[2]	Poor[2]	Excel
Responds to plating	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[3]
Responds to heat-treating	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[4]
Magnetic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	Austenitic Stainless			Martensitic Stainless			Nickel Alloys		
	Type 302	Type 316	Type 347	Type 410	Type 420	Type 440-A	S Monel	Cast Monel	Beryllium Ni (260C)
AS CAST									
Tensile Strength psi	80,000	81,000	77,500	156,000	100,000	102,300	134,000	65,000	115,000
Yield Strength psi	40,000	34,800	40,500	143,000	76,000	92,200	121,000	32,500	60,000
% Elongation in 1 in.	45.0	48.0	44.0	3.5	4.0	2.0	6.0	25.0	7.0
Hardness	Rb 84-86	Rb 73-75	Rb 73-75	Rc 32-38	Rc 27-30	Rc 36-40	Rc 33-38	Rb 76	Rc 24-30
ANNEALED									
Tensile Strength psi	75,000	78,000	78,300	100,000	95,000	95,500	99,300	———	90,000
Yield Strength psi	35,000	34,000	28,000	77,000	50,000	65,200	74,000	———	50,000
% Elongation in 1 in.	55.0	44.0	33.0	20.0	15.0	3.0	16.0	———	8.0
Hardness	Rb 80-83	Rb 76-78	Rb 86-89	Rb 96-100	Rc 18-22	Rc 20-25	Rc 24-26	———	Rc 20-25
HEAT TREATED									
Tensile Strength psi	———	———	———	204,000	220,000	———	140,000	———	200,000
Yield Strength psi	———	———	———	128,000	165,000	———	126,000	———	190,000
% Elongation in 1 in.	———	———	———	6.0	1	———	2	———	0-2
Hardness	———	———	———	Rc 40-44	Rc 45-48	Rc 58 max	Rc 42 max	———	Rc 52-56
Castability	Excel	Excel	Excel	Poor	Fair	Good	Good	Good	Good
Machinability[1]	25A	25A	25A	55A	40A	40A	35A	40AC	55A
Weldability	Good[2]	Good[2]	Excel	Fair[2]	Fair[2]	Fair[2]	Poor	Poor	Poor
Responds to plating	No[3]	No[3]	No[3]	Yes	Yes	Yes	No[3]	No[3]	No[3]
Responds to heat-treating	No[5]	No[5]	No[5]	Yes	Yes	Yes	Yes	No	Yes[4]
Magnetic	No[6]	No[6]	No[6]	Yes	Yes	Yes[7]	No	No	Yes

	Copper-Base Alloys				Aluminum Alloys			
	Beryllium Copper (260-C)	Silicon Brass (B-198-13B)	Navy "G" Bronze (B-143-1A)	Aluminum Nickel Bronze AMS-4640	Type 356	Type 355	40-E	Tern Alloy No. 7
AS CAST								
Tensile Strength psi	75,000	60,000	40,000	85,000	22,000	22,000	———	30,000
Yield Strength psi	40,000	24,000	18,000	40,000	15,000	15,000	———	19,000
% Elongation in 1 in.	30 max	15	20	10.0	0.7	0.5	———	2.0
Hardness	Rb 75-90	Rb 56-58	Rb 48-51	Rb 87-90	———	———	———	bhn 65 min
ANNEALED					(—T51)	(—T51)	(—T5)	(Note 8)
Tensile Strength psi	55,000	———	———	———	25,000	26,000	32,000	36,000
Yield Strength psi	30,000	———	———	———	17,000	18,000	22,000	26,000
% Elongation in 1 in.	50 max	———	———	———	3.0	1.5	3.0	3.0
Hardness	Rb 60-85	———	———	———	bhn 45-50	bhn 50-55	bhn 65 min	bhn 70-75
HEAT TREATED					(—T6)	(—T6)		(—T6)
Tensile Strength psi	175,000	———	———	100,000	32,000	33,000	———	40,000
Yield Strength psi	155,000	———	———	55,000	28,500	29,000	———	37,000
% Elongation in 1 in.	1	———	———	5.0	3.0	2.5	———	0.5
Hardness	Rc 40-44	———	———	Rb 93-97	bhn 65 min	bhn 70 min	———	bhn 75-85
Castability	Excel	Excel	Good	Fair	Excel	Excel	Fair	Fair
Machinability[1]	20AC	60AC	20AC	20AC	75 (—T6)	75 (—T6)	75 (—T5)	75 (—T6)
Weldability	Good	Good	Poor	Good	Good	Good	Good[9]	Good[9]
Responds to plating	Yes	No[3]	Yes	Yes	Yes	Yes	Yes	Yes
Responds to heat-treating	Yes[4]	No	No	Yes[4]	Yes[4]	Yes[4]	No	Yes[4]
Magnetic	No	No	No	No	No	No	No	No

1. Basis for rating is B-1112 steel equals 100 per cent machinability. A means annealed. AC means as cast.
2. Requires pre and postheat treatment for welding.
3. Not recommended.
4. Precipitation-hardening alloy.
5. Hardened by cold working only.
6. May be slightly magnetic when cold worked.
7. May be nonmagnetic in the "as cast" condition.
8. Twenty-one days at room temperature or 8 hours at 210 F.
9. For brazing.

Residual Stresses

. . . their effect upon parts produced from cold-finished steel bars

DESIGN ABSTRACTS

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RESIDUAL stresses may be defined as those stresses which exist in a material not subjected to any external force. Residual stresses are associated with some type of inhomogeneity within a material. Such inhomogeneity may be brought about by cold deformation, heat-treatment, precipitation, etc. Thus, any operation which results in nonuniform displacement within the material produces a resulting stress pattern. Residual stresses are elastic stresses and they can be obliterated by straining the material beyond the yield point.

At this stage of the development of our knowledge of residual stresses, such stresses have been classified into two types: macrostresses (body), and micro-stresses (tessellated stresses).

Residual macrostresses are considered to be those stresses which result from nonhomogeneous deformation (e.g., cold-drawing) extending over large portions of the deformed body. On the other hand, residual microstresses may be described as those stresses which result from deformation in local discrete areas of the material such as the atomic lattice or at a grain boundary, or the boundary between constituents having different mechanical properties.

Methods for measuring residual stresses which have been used to develop the information which follows measure essentially the macrostresses. These methods used for measuring residual stresses at best give approximations of the actual stresses. In the case of cold-finished bars where the residual stresses vary longitudinally, circumferentially, and radially, measurement is particularly complicated. In some instances, however, where the longitudinal stresses are considered to reflect the general situation with respect to stress distribution, only stresses in this direction are measured.

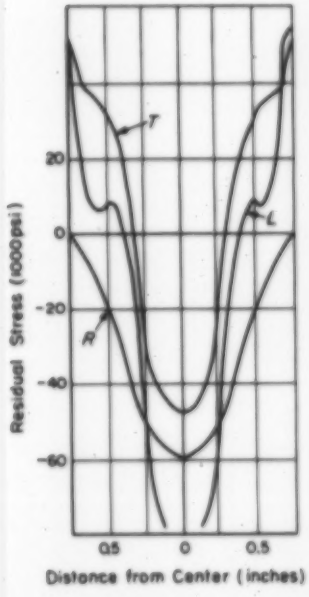

Fig. 1—Typical residual-stress distribution in a cold-drawn round, 0.45 per cent carbon-steel, 1½-in. diam. bar reduced 20 per cent. L = longitudinal T = tangential, R = radial residual stress

The distribution or residual stresses in cold-finished bars has been measured in two ways: boring-out method and deflection technique.

The boring-out technique is useful where information about all three principal stresses is desired. This method depends upon precise measurements of the dimensional changes as a solid bar or tube is carefully bored out from the center in a succession of small steps.

In the deflection technique, the variable deflection of an originally straight bar is measured as successive layers are removed from one of its surfaces. This deflection is a result of the residual stresses existing in the principal direction. This method is, therefore, useful where residual stresses are to be measured in one direction only.

Cold-Drawn Bars: Cold drawing is accomplished by pulling the pickled and lubricated hot-rolled material through a die with a hole whose smallest diameter is less

than the original diameter of the hot-rolled bar. Such a deformation process results in a residual-stress distribution of the type shown in *Fig.* 1. In general, these diagrams reveal that the surface stresses are tensile whereas the center of the bar is in compression.

This residual-stress distribution may vary depending upon the per cent reduction of the bar cross-section. Very low per cent reductions may result in compressive stresses on the surface rather than the normal tensile stresses. The intensity of tensile stresses increases to some critical per cent reduction and then levels off, and with higher reductions decreases.

Straightened Cold-Drawn Bars: Bars are generally straightened between two revolving skewed rolls. one of which is ground with a concave face and the other with a straight face. The bars are fed through, and as they proceed, they are bent in all planes. This bending straightens the bar and also affects the residual-stress distribution, *Fig.* 2.

The straightening operation effectively acts as a strain-relieving treatment with a resultant decrease in the level of stresses in the bar. It is of interest also to notice that the major effect is at the surface as could be expected since the greatest plastic strain is introduced there.

Straightening of cold-drawn bars also may be carried out by stretching. It has been demonstrated that such a process may reduce the longitudinal stresses by approximately 30 per cent and the tangential residual stresses by about 65 per cent.

Press straightening is used also in straightening large cold-finished bars. The local bending which produces a straight bar also introduces randomly modified residual stresses.

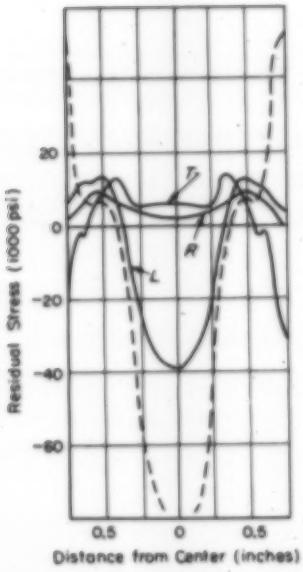

Fig. 2—Residual-stress pattern obtained after drawing, followed by rotary straightening. Bar is same as in *Fig.* 1, from which original *L*-curve (shown here dashed) is reproduced for comparison

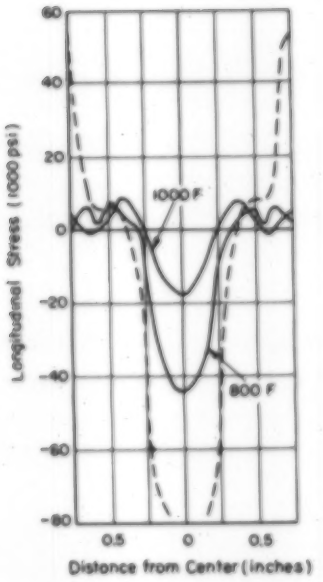

Fig. 3—Longitudinal residual-stress pattern after drawing and stress-relief treatment at temperatures indicated. Bar is same as in *Fig.* 2, from which dashed curve is taken

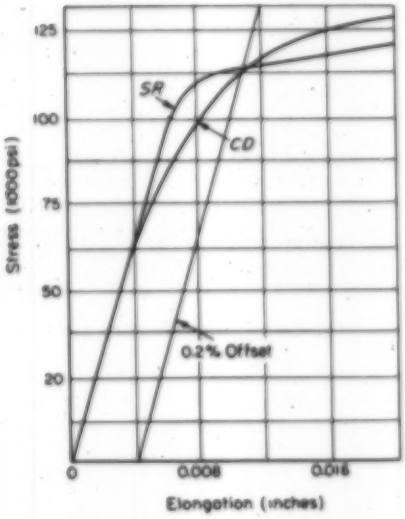

Fig. 4—Effect of stress relief at 900 F on yield strength of a cold-drawn 0.45 per cent carbon steel bar. *CD* = as drawn, *SR* = strain-relieved

Effect of Strain-Relieving: Cold-drawn bars may be strain-relieved at temperatures below the lower critical temperature to achieve desired physical properties, relieve stresses and modify the yield-tensile strength ratio. *Fig.* 3 illustrates the effectiveness of strain-relieving at two different temperatures with respect to lowering of residual-stress intensity. The higher temperature results, naturally, in a lower level of the locked-up stresses.

Equally important are the changes in shape of the stress-strain curve brought about by thermal treatment. In *Fig.* 4, the as-strain-relieved curve *SR* shows an increased elastic range as compared with the as-drawn condition *CD*. The ratio of yield strength to tensile strength is raised at the

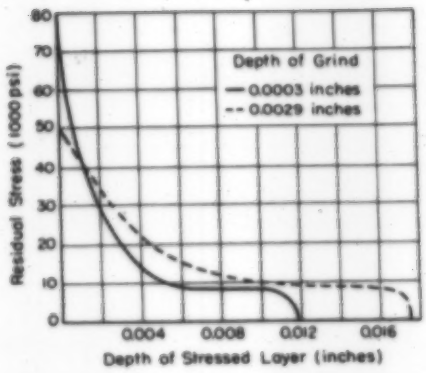

Fig. 5—Residual stresses at surface of a ground mild-steel bar

same time. By purposely varying the temperature and duration of the subcritical thermal treatment, it is possible to modify the tensile-yield ratio, and improve elastic properties, while substantially retaining the original tensile strength.

Turned Bars: This machining operation may introduce residual stresses of various characteristics depending upon machining conditions (bar and tool material, lubricant, speed, feed, tool angles).

Ground Bars: Hot-rolled bars, ground on centerless grinding machines, have a residual-stress distribution which, as in turning, is profoundly influenced by the grinding conditions as well as bar chemistry.

Available information indicates that tensile stresses are produced in a superficial layer whose depth may vary from 0.0001 to 0.003-inch. A typical distribution of residual stresses in a ground mild-steel bar is presented in *Fig.* 5.

Polished Bars: Polishing of bar stock may be accomplished with two-roll machines similar to those used for straightening. As the bar passes through the revolving rolls, the surface is burnished. The surface is plastically strained far in excess of the center of the bar. In *Fig.* 6, a stress distribution typical of such a polishing operation is illustrated. Of interest is the fact that surface tensile stresses may now be made compressive.

Heat-Treated Steel: Cold-finished bars are frequently heat-treated either before or after the cold-finishing process. Such treatment, of course, produces residual stresses. If heat-treated cold-finished bars are furnished, the stresses arising from heat-treatment are subsequently modified by the cold-finishing sequence.

The residual stresses associated with heat-treating are influenced by the chemistry of the steel, solution temperature, quenching medium, and heat-treating cycle. Either compression or tensile stresses may be produced on the surface of a bar after heat-treatment. Subsequent tempering treatments may then produce surface stresses varying from 3000 to 16000 psi.

Effects on Manufactured Parts: Such processes as machining, heading, heat-treatment, carburizing, straightening, plating, etc., will generally modify the original residual-stress distribution or may introduce new stresses. The relationship between the original stress distribution and the effects of subsequent processing is important in explaining phenomena attributable to such stresses. Some of the characteristics influenced are:

Strength Properties: Properties such as the ultimate strength or ductility of a part are not altered significantly by residual stresses. The yield strength, however, is modified to a considerable degree, *Fig.* 4. The change in yield strength described here is brought about by strain-relieving. The proportional limit is similarly affected.

Fatigue: Although considerable work has been done in the nature of fatigue in fabricated parts, this phenomenon is still not well understood. It is, however, generally believed that compressive stresses which increase the apparent strength of the surface undergoing fatigue will benefit the life of the part.

Cracking: High levels of residual stresses associated with stress raisers (notches, segregation, etc.) will cause cracking. Thus, the residual stresses should be kept low and the stress raisers removed by appropriate design or material specification. If low levels of stress can be maintained, a higher degree of tolerance for stress raisers is possible.

Machinability: Often cold-fin-

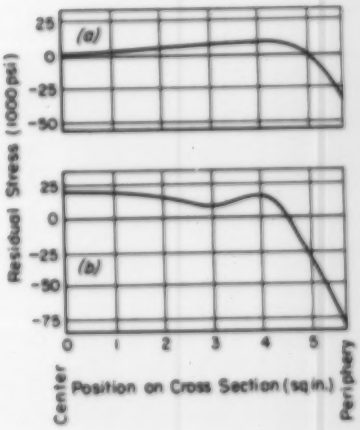

Fig. 6—Longitudinal residual stresses in a burnished 0.19 per cent carbon-steel bar, 2¾ inches diam: (*a*) Single burnishing pass resulting in a 0.0004-inch reduction of diameter; (*b*) Two successive burnishing passes, with 0.0010-inch diameter reduction

ished bars are machined during the fabrication of finished parts. The residual stresses in material being machined, if not controlled, may cause poor tool life because of seizure. The part may "close" on the tool, accelerating tool wear. In extreme cases, such seizure may result in tool breakage, for instance, during drilling.

Tolerances: Similarly tensile or compressive stresses may upset size or dimensional tolerances as the material is nonuniformly machined or processed.

Corrosion: Surface residual stresses, particularly tensile stresses, accelerate attack by corrosive atmospheres. Low levels of stress may improve the corrosion resistance of materials.

From a paper entitled "Residual Stresses in Cold-Finished Steel Bars and Their Effect on Manufactured Parts" presented at the ASME Semiannual Meeting in Boston, Mass., June, 1955.

Design factors in applying

Fluid Seals

By Robert H. Barbour and Robert O. Isenbarger

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THE topic of "fluid seals" covers a large range of materials, designs, and conditions. *Fig.* 1 illustrates a few of the many designs of fluid seals. It is misleading to state that a given design will function within any certain range of values of a given condition, since the ability to function at any time is dependent upon the combined effect of all of the conditions existing at that time. It is important to know not only as many of the conditions as possible, but their coincident value as well. For it might be true that while none of the conditions are serious in themselves, their combined effect at some part of the operating cycle might be critical.

A simple and obvious example of this would be the relation of pressure and speed on the ordinary rotating shaft seal. The speed the seal can stand decreases as the pressure increases. *Fig.* 2 shows the effect of this increased pressure. A greater amount of the sealing lip is brought into contact with the rotating shaft. This results in greater rubbing friction and heat build-up. If only these two conditions, or variables, were involved, the problem would be simplified. Actually, the allowable speed at a given time is dependent not only upon pressure but on shaft finish, ambient temperature, eccentricity, amount of lubrication, viscosity of the fluid, and the value of many other variables existing at the time. *Fig.* 3 shows a good installation of an oil seal on a rotating shaft application and a poor installation due to eccentricity caused by an inadequate bearing.

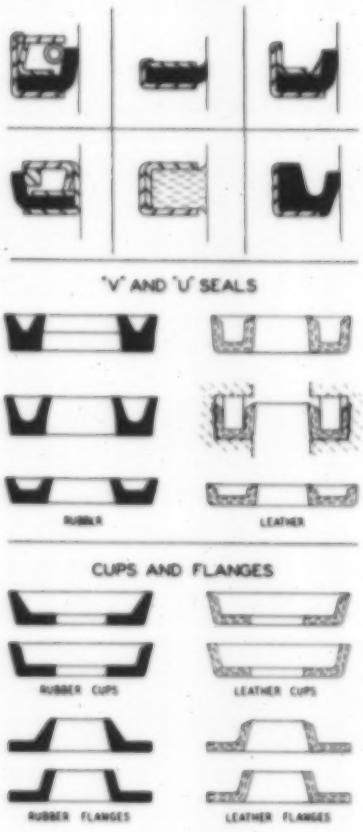


Fig. 1 — Several designs of fluid seals

Material Selection: Of course, these conditions not only affect the design, but they determine the choice of material from which the seal is to be made. There is no one ideal material for fluid seals. The various materials have certain outstanding characteristics which make them favorable for certain uses, while other physical properties of that particular material would make their use somewhat less desirable. In other words, where an application is out of "the run of the mill" class and has some rather difficult conditions, such as are being encountered more and more, a compromise usually must be reached between those physical properties desired and the properties which may be obtained when all of the physical properties of the material are taken into consideration. An example of this would be where extreme low-temperature flexibility is desired and yet, at the same time, extremely good oil resistance is required. Unfortunately, the materials having the best low-temperature flexibility do not always have the best oil resistance.

Design Factors: The physical properties of the various sealing materials must also be taken into consideration when developing the design of fluid seals. In the first place, parts made from these materials cannot be held to as close dimensional tolerances as can metallic parts. Therefore, it is im-

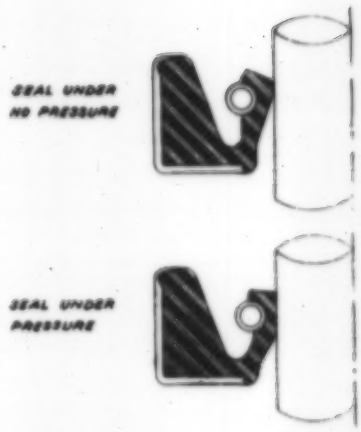


Fig. 2—Effect of pressure on a shaft seal

portant in making the design to allow for these greater tolerances.

The best design of a fluid seal is of little value if the part cannot be molded or shaped and finished economically. Things such as undercuts, flash lines on radii, sharp corners where the maximum flow is required, and others enter into the economical design of seals.

Engineers not experienced with elastomeric materials attempt to design fluid seals thinking in terms of the properties of various metals and not allowing for the fluid property of rubber-like materials. Since the various synthetic rubbers are relatively nonporous, as compared to a material such as leather which stores lubrication, they usually have a high coefficient of friction and are subject to abrasion if not lubricated. Therefore, in dynamic applications, care should be exercised that lubrication is present. It is important that the seal be lubricated upon installation because there can be a short interval of time before fluid reaches the seal. The sealing surface of the seal can be damaged even though the period of dry operation is very short.

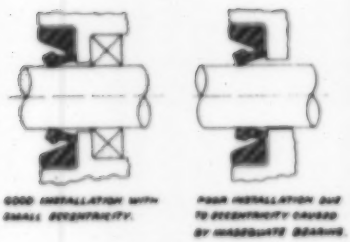


Fig. 3—Effect of eccentricity on a shaft seal

Hardness, smoothness and material of the surface on which the fluid seal will operate are very important. For instance, on rotating shaft seals, steel shafts are usually recommended having a hardness between 45 and 60 Rockwell C. Hardened steel makes the best surface against which a seal operates. Softer materials, such as copper, brass, and aluminum, particularly on rotating shafts, can be abraded rather rapidly by fluid seals. If it is necessary to use these materials, it is best to protect them with a hardened steel ring or case.

Finish of the surface on which the seal operates is very important. It is always best to polish the surface on which the seal rides even after a very fine grinding operation. Grooves resulting from spiral grinding would pump the oil past a sealing lip as the shaft rotates in the direction of the spiral. Polishing this surface has the effect of removing sharp peaks which would result in poor seal life.

Many seal failures are due to improper installation of the seal. Often insufficient space is allowed for the seal with the result that the seal which fits in this space is not efficient.

The use of seals for any function except for sealing should be discouraged. It is, of course, unwise to use seals as bearings or frictional devices and at the same time expect them to seal. Since they are not designed for such use, they would be unreliable and their sealing ability would be impaired. Adequate bearings in the mechanism must be provided to limit eccentricity or wobble to the point required for the particular seal and conditions involved.

Sealing problems in hydraulic applications are perhaps more serious than those involved in the average mechanism due to the large number of combinations of conditions involved. Even mechanisms which are quite similar often require different types of seals due to minor differences.

From a paper entitled "Fluid Seals" presented at the SAE Golden Anniversary Passenger Car, Body and Materials Meeting in Detroit, Mich., March, 1955.

Dissipating Heat in Electronic Equipment

IMPROVED performance, decreased size, greater reliability, and increased complexity of electronic equipment have increased the need for prevention of failures due to excessive heat.

In 1937, for example, a typical destroyer used about 60 vacuum tubes; by 1952 this total had increased to 3200 tubes. This increase has necessitated a reduction in equipment size, and consequently has concentrated the heat into a smaller area.

The primary heat transfer problem in electronics is the removal of internally developed heat through a reduction of the thermal impedance between heat sources

and the ultimate sink. A low-impedance thermal path will reduce the temperature rise of heat-producing electronic parts. Electronic heat removal can be divided into three phases: (1) removal of heat from the source, (2) the intermediate phase of transferring the heat along a thermal path to the ultimate sink, and (3) dissipation of the heat at the ultimate sink.

New concepts are in order because electronic parts are frequently designed and rated only for natural cooling in air at sea level pressures. Operation of electronic parts in low-pressure environments will require extensive thermal derating. Conversely, increased ratings can be applied in liquid environments. Parts with increased power dissipation will be required eventually.

Two Approaches: Two basic approaches to heat transfer are current: the "brute force" approach and the designed approach. The brute force method, wherein high temperature electronic parts are used without special cooling means, has frequently found application in some newer electronic equipment. High-temperature electronic parts now available in limited quantities have been used satisfactorily for this purpose. These parts are particularly suited to equipment operating at ambient temperatures of near 100 C.

The design approach embodies the most practical and effective methods of heat removal. The technique requires careful design of the entire heat transfer system and the establishment of controlled thermal gradients.

The phases of heat removal are interrelated. The method of ultimate heat dissipation depends somewhat on the type of intermediate heat transfer provided. For a complete heat removal system, all three cooling phases must be considered.

Vacuum tubes, resistors, and reactors are the principal sources of heat in electronic equipment. Vacuum tubes are usually the primary heat sources and also the sources most subject to failure. Their overall efficiency is low, and a large percentage of the total input power is converted into heat. Fundamentally, vacuum tubes are variable resistors, and it appears that little can be done to improve their efficiency. In some instances magnetic amplifiers or similar types of variable reactors have been utilized because such devices exhibit higher efficiencies. Transistors also show promise, and apparently they will be used in many applications to replace vacuum tubes.

Operation of electronic components near their maximum power ratings has increased the need for improved heat transfer and reliability. In addition, high transconductance pentodes with large

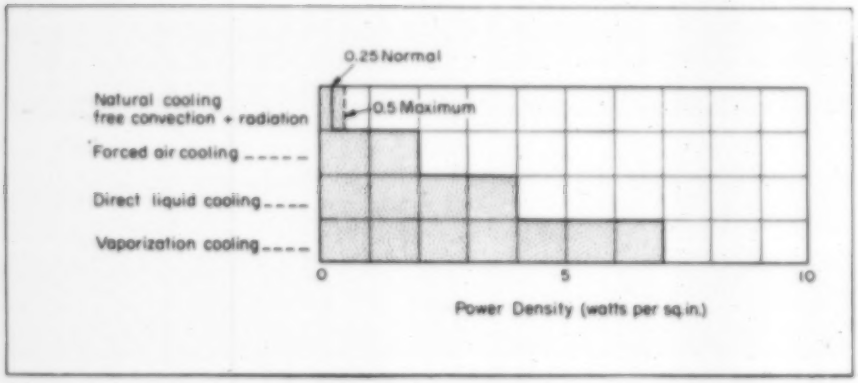


Fig. 1—Types of cooling appropriate for various power densities based on surface area, with 40 C rise

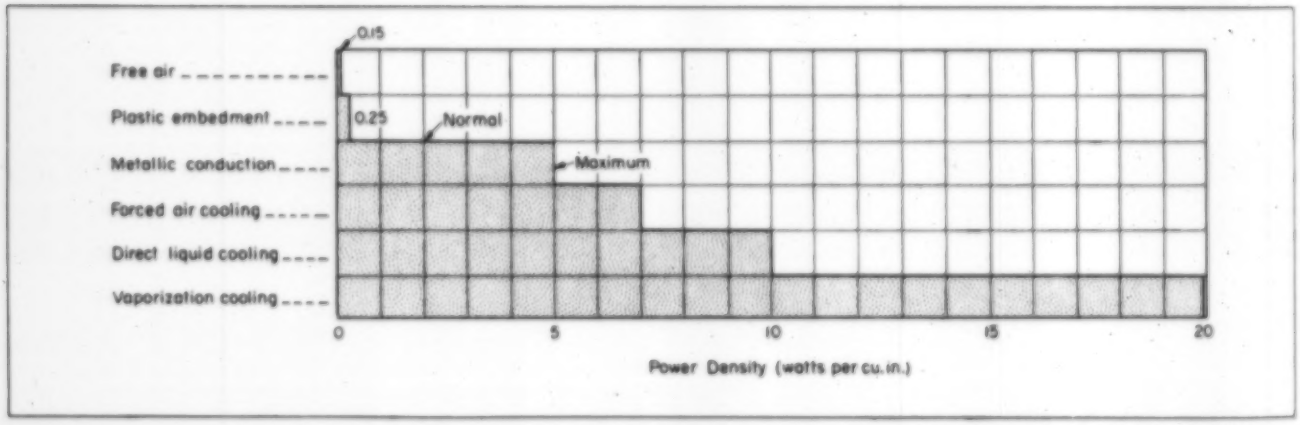
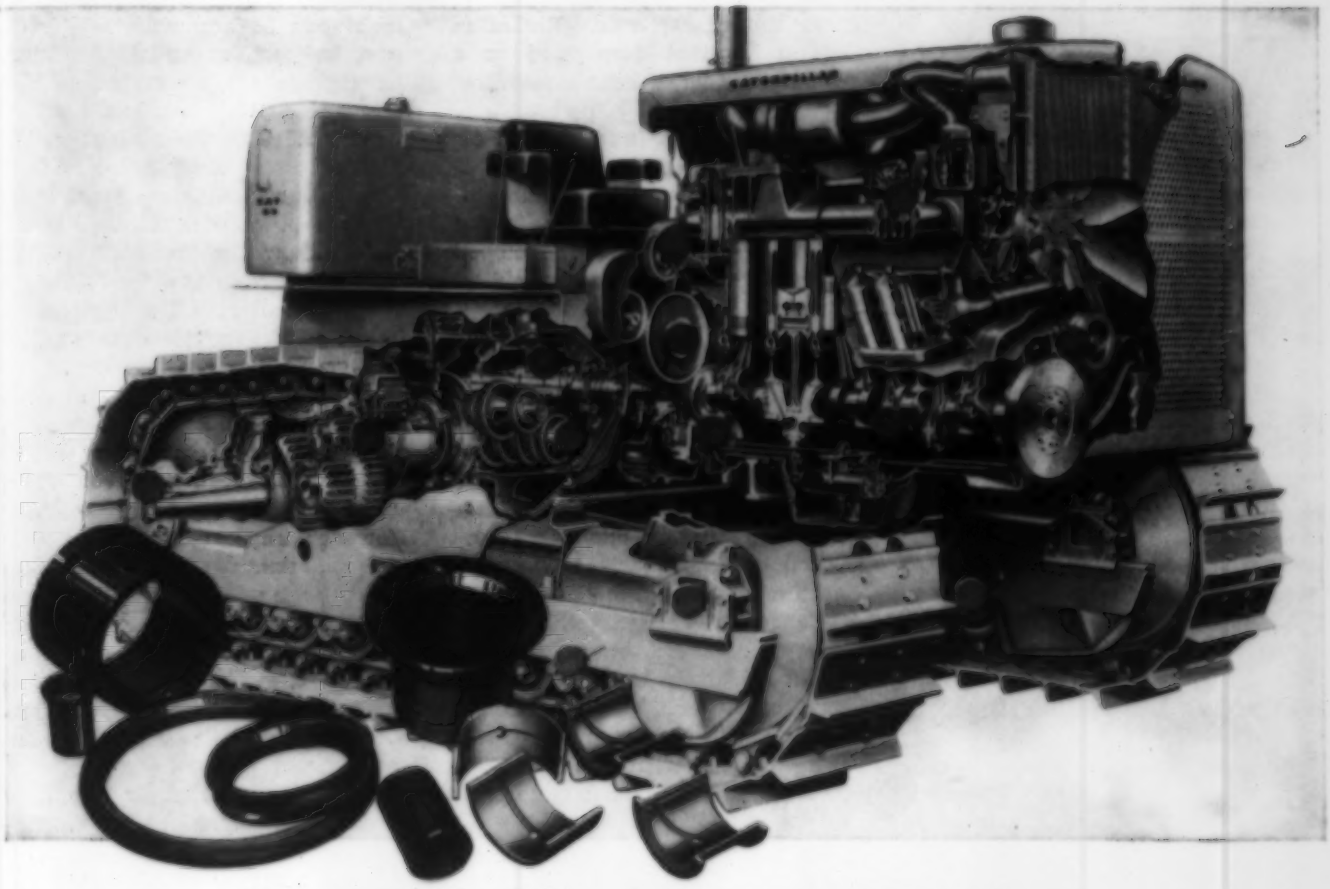


Fig. 2—Types of cooling appropriate for various power densities using volume as a basis, for internal cooling of sealed electronic units



Dependable Johnson Bearings Help Give Long Life To Big Cat Machinery

Engine bearings and bearings in track rollers and other components play a big role in the ability of Caterpillar Diesel Tractors to give long, satisfactory performance on tough jobs.

Caterpillar Tractor Co., manufacturers of the big yellow, earth moving rigs you see at every hand, makes certain that each part has the quality and stamina to give trouble-free service.

The ability of Cat equipment to handle difficult assignments depends in part on bearings obtained from Johnson Bronze Company of New Castle, Pa., which supplies a wide variety of the bearings used throughout Caterpillar products.

Dependable Johnson bearings—made of aluminum on steel, babbitt on steel, cast bronze, bronze on steel, and sintered bronze powder (Ledaloyl)—help Caterpillar meet its triple objective of: 1. durability, 2. bigger pay loads, and 3. longer life. Johnson also offers Caterpillar sound engineering help, has a complete line, maintains uniform high quality and consistently meets Caterpillar's specifications.

This is a typical example of the service Johnson gives many manufacturers in all industry by supplying them with many types of bearings for a wide variety of applications—from automobiles to sound recorders—from automatic washers to machine tools—to name but a few.

To enjoy the dependability and economy of Johnson bearings in your products, write for information on how Johnson engineers will work with you to make a better product at lower cost. Johnson Bronze Company, 525 S. Mill Street, New Castle, Pennsylvania.

Johnson Bearings

LEDALOYL (powder metallurgy) • ALUMINUM ON STEEL • BRONZE ON STEEL • STEEL AND BABBITT • CAST BRONZE

heat powers are frequently used in circuits in which low transconductance pentodes, if available, with approximately half the heat power could be utilized.

Cooling Methods: Natural methods of heat removal have been suitable for electronic assemblies in free air with power densities smaller than 0.5-watt per square inch. Plastic embedment, especially of vacuum tubes, has been found to be applicable to equipment of low power densities, but the poor conductivity and other thermal properties of plastics are not compatible with high power densities. This statement is particularly true when the equipment is subjected to continuous service.

Convection Cooling: Convection cooling of heat sources in electronic equipment is used by some organizations. However, the general trend is toward higher power densities which require the use of other cooling methods. Radiation cooling has not been used as a primary means of heat removal.

Forced Air Cooling: Forced air cooling is frequently used in electronic equipment. Special air-to-air heat exchangers with forced circulation have been developed for airborne electronic assemblies. Turbulent air cooling has been applied to devices of higher power densities.

Liquid Cooling: Liquid cooling has found acceptance for heat removal in some new equipment. Direct or indirect liquid cooling can be used depending upon the compatibility of the coolant with the electronic parts and circuit performance. Here again the disadvantages of these techniques with respect to maintenance must be considered. Heat has been transferred efficiently in high power density devices with silicone fluids, petroleum-base oils, and water.

Vaporization Cooling: Vaporization cooling of electronic equipment can be accomplished by direct, indirect, expendable, or non-expendable cooling systems. The absorption of the latent heat of vaporization of the coolant makes possible an efficient means of heat removal, especially in equipment of high power densities. *Figs.* 1 and 2 show the various types of cooling appropriate for different power densities. The graphs illustrate two methods for determining power densities: watts per square inch, using surface area as a basis; and watts per cubic inch, using volume as a basis.

Heat has been removed from vacuum tubes by many methods. However, improved means of cooling subminiature vacuum tubes, without the use of liquid or vaporization cooling, are required for equipment of medium power densities. The relationship of tube life to tube temperature has been found to be of the utmost importance.

From "Heat Transfer Problems in Electronic Equipment" in Bureau of Ships Journal, *October,* 1955.

Decimal Dimensioning

By Charles M. Wright

Standards Engineer
Engineering Div.
Chrysler Corp.
Detroit, Mich.

A DECIMAL system for dimensioning engineering drawings can usually be limited to two-place, three-place, or four-place decimals, the unit value being understood as 1 inch unless otherwise specified, as it would be in giving roughness values in microinches.

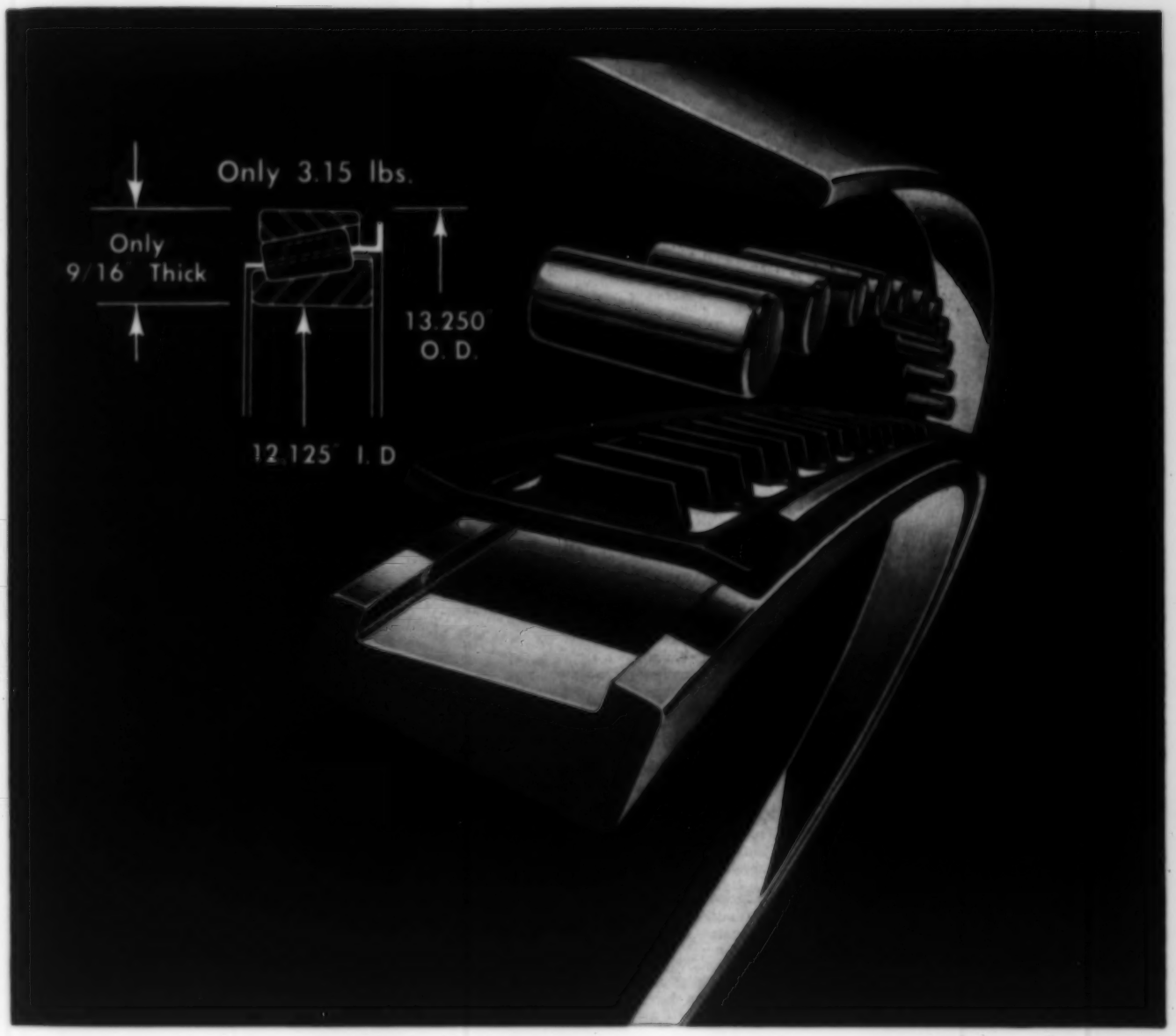
The number of decimal places in a dimension should carry no connotation as to the accuracy required. When they see three or four decimals, however, many engineers consider the dimension more important or precise than a one or two-place decimal. Actually, 0.1-inch is the same dimension as 0.10-inch or 0.100-inch. However, it is pretty well established in the decimal dimensioning systems now in use that (1) a decimal consisting of two figures after the decimal point shall be the minimum or basis so that all decimal values are expressed in no larger increments than hundredths of an inch; (2) no tolerance should be implied by the number of decimal places in a dimension; (3) all dimensions should be specified in two-place decimals except when converted from fractional dimensions or where tolerances require more than two-place decimals; (4) the dimensions should have the same number of decimal places as the tolerances.

Another detail, while it may seem arbitrary, is nevertheless generally accepted and applied, wherever design permits, by most organizations using decimal dimensioning. The inch is divided into tenths such as 0.10, 0.20, 0.30, etc., and even hundredths such as 0.02, 0.04, 0.06, etc., the smallest increment of the hundredths being 0.02.

Specification of even numbers in the second decimal place permits them to be divided into a decimal of two places, whereas a two-place decimal ending in an odd number would require specification of three places in the halved dimensions. Therefore, dimensions which are divided into two or more equal spaces, as between equally spaced holes, should be such that the resulting dimensions will be two-place or hundredths increments. Where the design requires overall dimensions which, when divided into two or more equal spaces result in dimensions expressed in three places, those three-place dimensions should be rounded off to two places wherever design permits.

No control is established over the odd or even characteristics of the last digit in three or four-place decimals. Whether they are even is generally dependent on design considerations, decimal equivalent of fractions or the effect of applied tolerances.

From "The Case for Decimal Dimensioning" in The Magazine of Standards, *August,* 1955.



Kaydon...
world's thinnest tapered roller bearings

Reali-Slim — that's the name we've given our line of extremely thin-section, lightweight bearings. The bearing shown above is a *Reali-Slim*. *Reali-Slim* bearings are really strong, too! The single row, tapered roller bearing we're talking about, here, has a 33,000-lb. radial capacity—with 38,200-lb. thrust capacity. Over 1-ft. in diameter, yet it weighs only 3.15 lbs! These figures tell how *Reali-Slim* bearings combine minimum section with high strength and long life.

If you're looking for a whole new concept in thin-section, lightweight bearing design — look at Kaydon's *Reali-Slim* line. In addition to hundreds of *Reali-Slim* standard sizes, there's a big variety of special races and separators to meet special applications. Kaydon engineers are prepared to give you valuable help with your application problems.

For more information write Kaydon of Muskegon. Ask for engineering Catalog No. 54-RS detailing:

★ ***Reali-Slim Ball Bearings*** — in Conrad, angular contact and 4-point contact types are available in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40.000".

★ ***Reali-Slim Roller Bearings*** — in radial and taper roller types are available in cross sections from 9/16" and in bore diameters from 5" to 40.000".

K-55

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings.

Helpful Literature

(Continued from Page 222)

formance and maintenance of basic Dynamatic electronic controls. Principles utilized to accomplish stepless speed control of Dynamatic eddy-current rotating equipment, using an ac line as the power source, are described in detail.

38. Laminated Plastic Service

Formica Co.—Industrial sheets and rods of laminated plastic are now available on a national basis for immediate shipment from stock. This service, in addition to those of engineering, research and fabrication, are described in 8-page bulletin 584. Company offers 53 standard grades of laminated plastics with wide variety of electrical, chemical and mechanical properties.

39. Precision Needle Rollers

Kaydon Engineering Corp.—Engineering information, complete with charts and formulas, is provided in 12-page catalog 61 on precision needle rollers. Available from stock in spherical, conical and flat end types, rollers are used in practically all types of machinery. Listing of standard sizes and application data are highlighted.

40. V-Belt Drives

Allis-Chalmers Mfg. Co.—74-page "Tex-Book 20P40" provides multicolor tables for quick and easy selection of constant speed Texrope V-belt drives. Line of variable speed drives covered includes units rated as high as 600 hp and constant speed drives of up to 3000 hp. Data includes information on design features, basic drive principles and technical data on sheaves.

41. Magnetic Pulleys

Stearns Magnetic, Inc.—Simplified selection method used in 16-page bulletin 303-C on Electromagnetic pulleys and pulley separators facilitates selecting the right size for a particular application. Bulletin also highlights the new two-coil pulley design which creates a magnetic field of increased strength and more effective shape.

42. Three-Dimensional Cams

Parker Stamp Works, Inc.—The evolution of three-dimensional cams from theory to working finished product is described in technical folder 4558. Cams find use in automation, instrumentation and supersonic aircraft controls.

43. Modern Power Linkage

Twin Disc Clutch Co.—The evolution of machine tools is traced in 24-page issue of "Production Road." Developments in power linkage are related, with emphasis given to Twin Disc friction clutches, fluid couplings and hydraulic torque converters and their use in the machines of today and the future.

44. Molded Rubber Goods

Quality Rubber & Transmission Co.—Molded rubber goods made to specification for particular industrial and commercial use are described in 4-page bulletin M-1. Chart lists qualities of natural rubber, neoprene, Buna N, Buna S, butyl and silastic silicone rubbers, for a variety of applications.

45. Set Screws

Set Screw & Mfg. Co.—24-page illustrated catalog No. 19 is devoted to data on regular and special set screws, their prices and specifications. Technical and application information for users is included.

46. Hose & Couplings

Imperial Brass Mfg. Co.—Hose assemblies for hydraulic and other heavy duty applications can be made up from line of Hi-Duty pressure hose and reusable couplings described in 12-page illustrated catalog 3040-A. Included are details of single and double wire braid, rubber and cotton covered SAE and JIC hose and wide range of couplings and adapters.

47. Fabricating Facilities

Fritz W. Glitsch & Sons, Inc.—Company's facilities for producing intricate tooling and fabrications of ferrous and nonferrous materials, alloys and stainless steels are outlined in 8-page illustrated brochure. It is equipped to form, draw, bend or weld heavy plate or sheet metal in making products for many industries.

48. High Resolution Plates

Eastman Kodak Co.—Information on Kodak high resolution plates used in manufacture of optical instruments is found on illustrated 2-page data sheet P3-123. They have a resolving power in excess of 1000 lines per millimeter. Technical data, sizes and prices are included.

49. Electrical Equipment

Electronic Specialty Co., Contract Div.—Voltage sensing devices, timers and time delay relays, flashers, special aircraft devices, test equipment and miniature components are among airborne electrical, electro-mechanical and electronic assemblies listed in engineering design catalog. Specifications are given.

50. Subminiature Potentiometer

DeJur-Amsco Corp.—Series of ⅝-in. diameter miniature potentiometers that weigh ½-oz is subject of 2-page illustrated data sheet C078. The completely enclosed C-078 units can be provided as single or multiple ganged units. General specifications are outlined.

51. Silicone Rubber

Dow Corning Corp.—Five sections of 4-page form 9-102 detail properties, and performance of Silastic silicone rubber as affected by extreme temperatures, weathering, compression, chemicals and dielectric service. Included are charts, tables, graphs and application photos.

52. Heavy Duty Limit Switch

R. B. Denison Co.—Data on contact arrangements, ampere rating, operating and electrical characteristics are contained in file folder type catalog on the Loxswitch heavy duty limit switch. Various mounting plates, actuators and covers available are described.

53. Laminated Plastic

Continental-Diamond Fibre Co.—20-page illustrated catalog D-55 contains diverse information on Dilecto laminated plastic, available in sheets, tubes, rods and fabricated specialties. Asbestos, fabric, glass, paper, polyester and other base grades are described. Properties for all grades are presented. Technical data in table form are given.

54. Levers & Control Units

Batavia Metal Products Corp.—Extensive line of levers and control units for trucks, buses, earth movers, hydraulic equipment, hoists, cranes, pumps, oil rigs and other equipment and machines is covered in 12-page bulletin HW-B3. Chart shows how they are assembled from standard forgings. Also included are detailed drawings and application photos.

55. Indicating & Recording Units

Barber-Colman Co., Wheelco Instruments Div.—Indicating and recording instruments that provide accurate measurement, indication and permanent record when applied to electrical variables such as voltage and amperage are described in single-page illustrated bulletin F-5605-1. Use can also be as tachometers.

56. Stainless Steel Fasteners

Allmetal Screw Products Co.—Types of fasteners and sizes in stock are among data on stainless steel fasteners found in 8-page illustrated condensed stock list. Included are screws, bolts, nuts, washers, rivets, AN fasteners, nails and pins.

57. Stainless & Nickel Tubing

J. Bishop & Co. Platinum Works, Stainless Steel Tube Div.—Eleventh edition of stainless steel tubing and tubular fabricated parts catalog gives data on comparative analysis of alloy types, specifications, tolerances, properties and relative workability. Covered are cold drawn mechanical, capillary and hypodermic, nickel and nickel alloy tubing. Machining details are also given.

58. Production Facilities

Acme Industrial Co.—Facilities for machining, grinding and lapping are described and illustrated in 4-page bulletin. Specific operations that can be performed are listed, and typical products are shown. Work can be finished from rough machined or partially finished stages or from bar stock, forging and castings.

59. Investment Casting

Austenal Laboratories, Inc., Microcast Div.—"Design—With Microcast in Mind" is a 12-page illustrated brochure that outlines the steps involved in investment casting and wide range of intricate parts that can be mass produced. Table of investment casting alloys is included, as is history of the 4000-year-old process.

60. Flexible Shafting

Elliott Mfg. Co.—"What Will Flexible Shafting Do for You?" is an illustrated 8-page folder (No. 247) that uses words and pictures to cover some diverse applications of flexible shafting in power transmission. Applications include tractors, farm machinery, vibrators, grass trimmers, ceiling grinder, mixer and machine tools. Preliminary selection chart is included.

61. Polyethylene Details

American Agile Corp.—Molecular structure of polyethylene and its mechanical, electrical and chemical properties and characteristics are detailed in 8-page illustrated booklet. Typical fabrications and applications are illustrated. Chart presents weights of seamless centrifugally cast plastic tubing based on inner and outer diameters.

62. Air Motor & Valves

Bellows Co.—Information on air motor and its interchangeable valves, plus typical application photos are included in 8-page bulletin ML-3. Also described and illustrated are such standard controlled air power devices as drill press feeds, vises, Hydro-Checks, rotary feed and index tables, drilling units, valves and cylinders.

63. Sintered Metallic Oxides

U. S. Stoneware Co.—Properties of Alite sintered metallic oxides are described in 8-page bulletin A-7. Suitable for high temperature uses in mechanical, chemical and electrical applications, they have their properties, chemical resistance, methods of joining, size limitations and electrical characteristics given.

64. Cold Drawn Steels

Republic Steel Corp.—"Quick Facts About Republic Union Cold Drawn Steels" is a revised 32-page booklet that summarizes the cold drawing process and presents basic data on commercial cold finished products. Properties and applications of typical grades of cold drawn carbon, free machining, stress relieved, leaded and alloy steels and Enduro stainless steel are included. Shafting, special sections, furnace treatment and carbon correction are covered.

65. Stainless Steel

Allegheny Ludlum Steel Corp.—AM-350, a chromium-nickel-molybdenum stainless steel which is hardenable by subzero cooling or double aging is subject of 12-page illustrated Technical Study No. 5. Tables on mechanical, stress rupture and elevated temperature tensile properties; corrosion rates in various media; and effects of cold rolling and aging on hardness and tensile properties are included in contents.

66. Asbestos Sheet Packing

B. F. Goodrich Co., Industrial Products Div.—Specifications and uses for 11 grades of compressed asbestos sheet packing are given in 4-page data sheet 5050. Included are sheets for severe conditions, synthetic bonded neoprene and Hycar types for use where oil and solvents are involved, and competitive quality types for general purpose use and where price may be a factor.

26 56

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Accelerated Developments Call for Greater Frequency

Products of American industry daily become more complex. Almost overnight, new developments spring forth . . . at a rate undreamed of when MACHINE DESIGN was established as a monthly 25 years ago. The entire area of design engineering has literally outgrown the method of editorial coverage which served the field so well in the past.

To meet the needs of design engineers, the editors of MACHINE DESIGN have increased the frequency of publication to every other week.

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It means a slimmed-down, easier-to-read, more timely book. Our editorial volume has doubled in the past 10 years. Even this rate of improvement will be outstripped so that MACHINE DESIGN may continue to deliver increasingly complete coverage of subjects important to engineers. Twenty-six issues will enable us to speed even more information to readers, in a more practical-sized format.

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What Every Other Week Means to Advertisers

It means greater visibility for the advertiser's message because of fewer pages per issue . . . and therefore the possibility of even more thorough readership of advertising. It means faster and greater pass-along readership. It means 26 opportunities a year to present sales stories to the more than 100,000 design engineers who read MACHINE DESIGN.

MACHINE DESIGN
A PENTON PUBLICATION

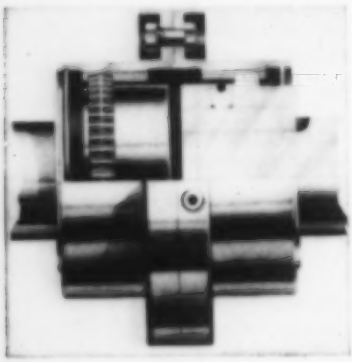
NEW PARTS AND MATERIALS

For additional information on these new developments, see Page 221

Self-Aligning Couplings 67

handle 3-deg misalignment

Line of 3D dihedral couplings is designed to handle misalignment up to 3 deg between driving and driven shafts of direct-connected machines. Tooth design permits



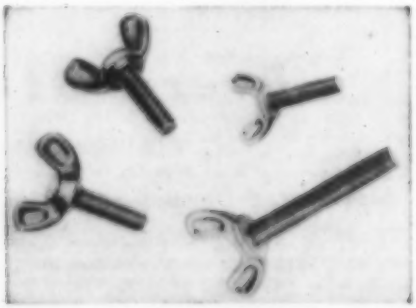
close clearance, and no end-of-tooth wear occurs under misalignment, because the load is normally carried at the center of the tooth. Under maximum rated misalignment the driving force is carried across an entire half tooth. Lubricant is sealed in. Available in five sizes, the couplings are designed for NEMA motor shafts using standard keys. **Ajax Flexible Coupling Co. Inc.**, Westfield, N. Y.

Circle No. 67, Page 221, for more data

Die-Cast Fasteners 68

available in wing or round-head thumb types

Completely die-cast wing screws, assembled wing screws and round-head thumb-screws are available in line of zinc alloy fasteners. The shoulder type cast wing screws are one-piece fasteners with machine



threads and recessed finger grips. The assembled wing screws and thumbscrews incorporate GRC senior wing nut and thumbscrew bodies assembled to a machine screw and are available in thread sizes from No. 3 through ½-in., in any length, and of specified materials such as steel, brass or aluminum. Cone, cup, dog or oval points are available on all three types of fasteners. **Gries Reproducer Corp.**, 400 Beechwood Ave., New Rochelle, N. Y.

Circle No. 68, Page 221, for more data

Universal Joint 69

miniature unit for instrumentation

Miniature ball-borne universal joint is designed for use in instrumentation or other equipment

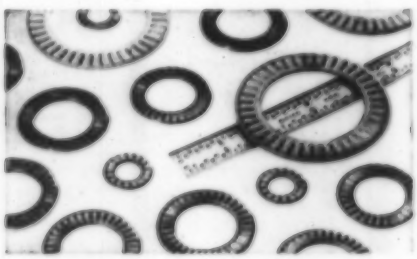
operating at low mechanical power levels. The Mini-Joint pivots on preloaded bearing surfaces which are ground and lapped balls providing continuous contact with zero backlash. They are high tensile strength steel alloy and can be heat treated. Stainless steel joints can be specified. Shaft hub holes are available in 1/32-in. increments from 3/32 to ¼-in.; body diameters are in 1/16-in. increments from 3/16 to ⅜-in.; and lengths are 1¼ and 1½ in. Maximum operating angle is 30 deg from collinear position. **Falcon Machine & Tool Co.**, 209 Concord Turnpike, Cambridge 40, Mass.

Circle No. 69, Page 221, for more data

Needle Thrust Bearings 70

provide high capacity in small space

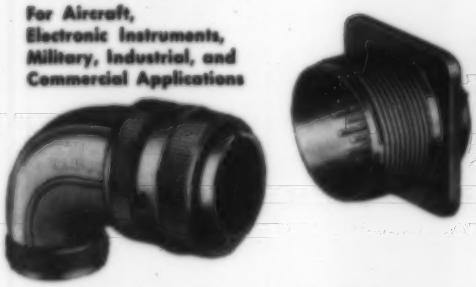
Compact NTA series needle thrust bearings support heavy loads. Designed for thrust loads, these bear-



ings also can be used with needle roller bearings for combined loads. Four sizes presently available are ½-in. bore by 15/16-in. OD; ¾ x 1¼ in.; 1 x 1 9/16 in. and 1¼ x 1 15/16 in. Bearing bores are designed for a running fit on standard shafts. The cross section, or roller diameter, is 0.078-in. thick. The retainer is composed of two mating halves, which are steel stampings, joined by spinning to effect a self-contained unit closed on both the outer and inner diam-

AN (STANDARD)

For Aircraft, Electronic Instruments, Military, Industrial, and Commercial Applications



Standard AN-A, AN-B, AN-C . . . meet Specification MIL-C-5015B. **Plastic inserts.** 15 diameters, 260 insert layouts, 6 shell styles. AN3100 to AN3108 with all accessories. Interchangeability an outstanding feature. Many type assemblies directly available through distributors.

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AN-E (INT. AN-M)

Where Vibration Resistance and Moisture Proofing Are Needed

AN-E Series . . . environment resisting. Replaces "old" AN-M. Meets Specification MIL-C-5015B. Resilient inserts. Completely sealed from cable to cable. Integral clamp and bushing. Grounding lugs. Interfacial sealing with grommet and grommet follower. Available as Interim AN-M with ferrule in place of grommet follower.

The "AN" and associated series connectors offer the

GS (HERMETICALLY-SEALED)

For Use Under Critical Pressure Conditions

Hermetically sealed connectors . . . with steel shells and contacts to withstand high pressures. Available in GS (AN type), KH, RKH, U, BFH, TBFH. Insulation is Conseal glass material, fused under high temperature to shell and contacts . . . giving *true hermetic sealing* when soldered or brazed to housing.

STEEL SHELL FIREWALL

For Open Flame Protection Wherever High Temperatures Are Involved

AN-K and Cannon FW Firewall Connectors . . . *offer you the greatest variety of this type of connector.* Cannon made the first firewall connector and continues the leader in the field. Wall—or box-mounting receptacles. Straight or angle 90° plugs. Crimp-on contacts. Inserts of asbestos-filled or glass-filled materials.

CONNECTORS SUITABLE FOR POTTING

For Resistance to Moisture, Fuel Oil, Gasoline, etc.

CA06 and CA3106 Types . . . developed for the Bu Aer Standard AN3106 type minus the end bell. Special plastic "cups" supplied for use as a mold while potting the rear of the connector. Weight saving. Grounding means available. Plastic or resilient inserts.

widest selection of types for all applications to Spec. "MIL"

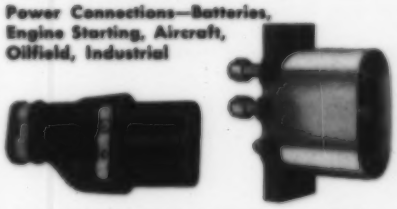
AF, F (VIBRATION PROOF)

For Points of High Vibration Where Extra Strength Is Needed

Vibration Proof CA310*F—CA0*AF Solid Shell, Resilient Insert Connectors . . . Feature extra strong coupling nuts . . . in hex, spline, knurled types for airline use. In wall—or box-mounting, cord-connecting type receptacles. Straight or angle 90° plugs.

AN EXTERNAL POWER

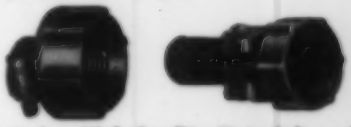
Power Connections—Batteries, Engine Starting, Aircraft, Oilfield, Industrial



CA2551, AN2552, AN3114 and Other Cannon Types Offer Most Complete and Varied Line . . . in single, double, and three contact fittings. Really rugged! Designed and built for safe, positive connection and long-lasting service.

AN ACCESSORIES

Cable Clamps, Conduit Fittings, Dummy Receptacles, Junction Shells, Dust Caps, Bonding Rings, Bushings, Adapters



Featuring High-Quality Materials and Workmanship . . . including AN3057, AN-3057A, AN3420, AN3054, AN3055, AN30-56, AN3058, AN3064, AN3066, AN3068, AN3111, 2120, 2245, 17530, 2209, 2182. Adaptable to all makes of AN connectors.

Cannon Plugs—standard of quality for the industry

W

For Underwater and Severe Moisture Conditions

W Waterproof Series . . . used underwater and on equipment operating in swamps, rivers, lakes, with underground cables—wherever conditions require thoroughly sealed fittings. Exceptionally rugged. AN type inserts. Acme threads on coupling nuts. Special rubber sealing ring. Special heavy duty cable clamp available.

OTHER SERIES . . . Audio Types—External Power Connectors—Switching Types—dc Solenoids—Guided Missile Launching Connectors—Miniatures and Sub-Miniatures.

40th YEAR 1915-1955

Since 1915

Write Today for new, completely revised, up-to-date AN10 bulletin!

Please refer to this Magazine or to Dept. 185

CANNON PLUGS

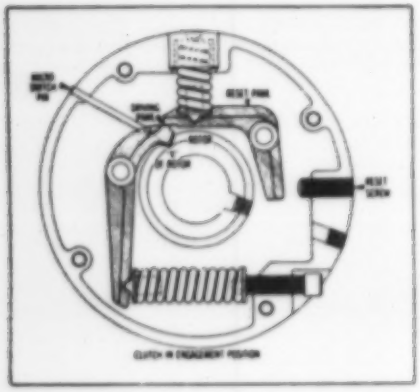
CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles; East Haven; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities.

eters. The flange construction closing the outer diameter stiffens the assembly and helps to maintain dimensional stability during heat treatment. The needle rollers are hardened high-carbon, chrome steel precision ground and lapped to a tolerance of 0.0002-in. on the diameter. **Torrington Co.**, Torrington, Conn.

Circle No. 70, Page 221, for more data

Overload Release Clutch 71

incorporates switch to shut down power supply



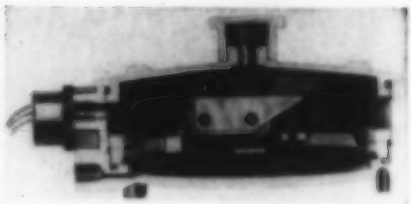
Trig-O-Matic overload release clutch prevents overloads in power drives by providing torque limits without any wearing parts. When the clutch is in the engaged position it is preset to a definite torque limit through use of two coil springs which are adjustable to any required torque range accommodated in the eight basic units available. When the torque limit is overcome by an overload, the driving pawl is disengaged and locked out by a reset pawl. At the same time a Micro Switch is actuated and power supply is shut down or a signal is provided. **Centric Clutch Co.**, U.S. Route 9 at Main St., Woodbridge, N. J.

Circle No. 71, Page 221, for more data

Pressure Difference Switch 72

senses pressure difference of up to 45 in. of water

Diaphragm pressure switch designated model 227 is sensitive to pressure differences from 0 to 45 in. of water between a variable and a reference pressure, with a fixed actuation value of 0.5-in. of water. The reference pressure



must be air or an inert gas; the variable pressure can be liquid or gas. The switch actuates an electric circuit on an increase or decrease of a predetermined pressure difference. It is not sensitive to jarring or vibration and will operate in any position. It incorporates a single-pole, double-throw, snap-action switching element rated for both ac and dc. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle No. 72, Page 221, for more data

Compression Springs 73

ready-wound in 26 sizes

Designed to fit into holes and over rods, these compression springs are made from music wire. They are ready-wound in 26 sizes ranging from 0.032 to 0.115-in. diam.

All springs are made 10 in. long and are easily cut to required size. **Reid Tool Supply Co.**, 332 W. Delano Ave., Muskegon Heights, Mich.

Circle No. 73, Page 221, for more data

Miniature Coupling 74

rated at 8 lb-in. torque

This miniature Oldham type mechanical coupling is rated 8 lb-in. torque and will accommodate 1/16-in. offset and 5-deg shaft misalignment. Coupling measures ⅜-in. diameter by 11/16-in. long and is nickel-plated brass with a nylon center piece for free sliding action and for electrical insulation be-

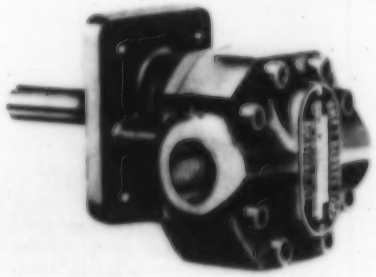
tween the ends. Standard types have two holes at each end 90 deg apart and tapped for 4-40 N.C. setscrews. Units are also available with single spotting hole for 1/16-in. shear pin, or with plain unbored ends. Couplings for ⅛, 3/16 and ¼-in. diam shafts are offered. **Kupfrian Mfg. Corp.**, 382 State St., Binghamton, N. Y.

Circle No. 74, Page 221, for more data

Hydraulic Motors 75

have flow deflector pins

Compact, lightweight hydraulic motors are designed with a deflector pin centered in the inlet



stream to minimize pocketing effect. Construction of the housing provides good starting torque. Gear tooth structure is such that mating spaces are filled, forming a seal and eliminating intermittent surge and vacuum conditions. The deflector pin has a minimum clearance with tooth tips. At the inlet side of the motor, clearance is provided between the first tooth and the housing to permit pressure to act on the teeth with a maximum moment arm. Motors are made in ratings to 2 hp and are available with a speed reducer drive. **John S. Barnes Corp.**, 301 S. Water St., Rockford, Ill.

Circle No. 75, Page 221, for more data

Gasket Material 76

is resistant to water, oil and gasoline

Approved by Underwriters' Laboratories for use in equipment where harmful liquids are encountered, Garlock 662 tight-sealing gasketing material can be used at temperatures to 300 F. It is made of a cork-base paper impregnated with Goodyear Chemigum latex, which is resistant to water

DOWEL PINS

HOW TO USE THEM

1. Precision Dowel Pins are principally used where parts must be accurately positioned and held in absolute relation to one another whether stationary or in motion. They facilitate quick disassembly and completely accurate re-assembly.
2. Allen Dowel Pins are also used as plug gauges.
3. As plugs for determining angular dimensions of dovetail slides.
4. As hinge and wrist pins in applications requiring initial and permanent accuracy.
5. As accurate, economical roller bearings and axles.
6. As guide pins, stops and position locators.

HOW TO JUDGE THEM

1. *On precision, for low tolerance applications.* (Allen Dowel Pins are ground to a maximum microinch finish of 6 RMS protected by a rust preventive.)
2. *On strength, for shear resistance.* (Allen Dowel Pins are made from special Allenoy Steel, heat treated. Single shear strength measures from 160,000 to 180,000 psi.)
3. *On hardness of surface and a core hard enough to prevent "mushrooming" when driven into a tight hole.* (Allen Dowel Pins have a surface hardness of 62-64 Rockwell C Scale and core hardness of 52-54. Average case depth .010 to .020 depending on size.)

The simple sure way to be sure of uniformly superior dowel pin quality is the same as in buying precision socket screws — *get genuine Allens from your Industrial Distributor.* Only he sells them but *we will welcome your direct request for literature or application engineering assistance.*

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SUPER-WIZARD

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5 watts input.
Balanced Armatures.
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Purchase cost only 18c per million counts.

50,000,000 COUNT LIFE

PIC
600

1000 counts per minute
7 watts power consumption
Balanced armature
Quiet operation. No AC hum.
Tamper proof housing.
Lubrication not required.
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PIC MERCURY
4-digit Reset

600 Counts per minute.
3 watts power input.
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3,000,000 COUNT LIFE

PIC MERCURY
5-digit non-reset

600 Counts per minute.
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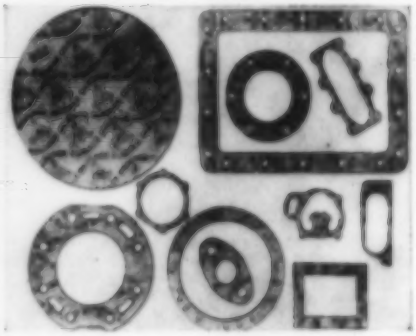
New Parts and Materials



oil and gasoline. Unaffected by changes in moisture content, it will not shrink. Material is made in thicknesses from 0.01 to 0.25-in., and cut gaskets are available in various shapes and sizes up to 48 in. **Garlock Packing Co.**, Palmyra, N. Y.

Circle No. 76, Page 221, for more data

Double-Row Ball Bearing 77

can utilize parts of end product for races

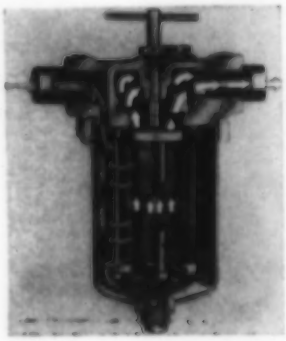
Versa-Twin double-row unground ball bearing is made to specific product requirements. Its inner race can be the shaft of the product on which it is used, an adaptation of it or a shaft fitted to a part by means of a screw, snap ring, rivet, spotweld or knurled press. The outer race can also be a functional component of the product. Stable bearing can carry radial and thrust load in both directions, locking the moving parts into the desired axial position. Unhardened and hardened Versa-Twin bearings are available. Use can be as a single bearing to support a motor or drive shaft, as a means to handle eccentric loads, as a pressing roller, or as a complete axle and housing. Bearing can be made of almost any material or combination of materials in virtually any size. **Hartford Steel Ball Co.**, Versa-Twin Div., 12 Jefferson Ave., West Hartford 6, Conn.

Circle No. 77, Page 221, for more data

Micronic Filter 78

causes comparatively small pressure drop

Small, cleanable, edge type Super Auto Klean filter removes micronic particles from large quantities of liquid. It stops all particles larger than 40 microns. In a typical application, one of these filters handles 30 gpm of 200 SSU oil with



only 3-psi pressure drop. Pressure drop remains small over a long period of operation. Cleaning is accomplished without stopping flow, and accmumulated sludge can be drained off through the bottom drain plug. Filter is metal and is 15 in. high and 6 in. in diam. **Cuno Engineering Corp.**, 80 S. Vine St., Meriden, Conn.

Circle No. 78, Page 221, for more data

Servo Control Valve 79

for follow-up positioning systems

Model CO-5 servo control valve is designed for use in follow-up positioning systems where mechanical input signals are obtained from cams or linkages. Positional feedback is obtained through the use of differential input linkages or by displacing the valve body relative to the spool motion. Valve design includes rectangular internal ports for linear flow output at constant valve pressure drop, precision lapping for positional accuracy, and hardened and lapped sleeve and spool construction. All hydraulic connections are grouped

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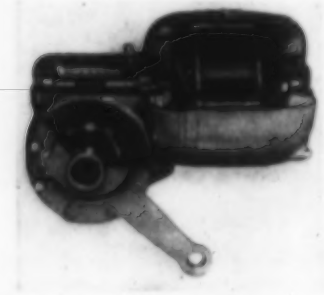
at the top of the valve. Valve flow versus displacement characteristics are easily modifiable to suit individual power and stability requirements. **Hydraulic Controls Co., 87 Terrace St., Roxbury 20, Mass.**

Circle No. 79, Page 221, for more data

Right-Angle Gearmotors 80

are shaft-mounted

Right-angle, single worm gear gearmotors are available with hollow output shaft for shaft mounting. Ratings range from ¼ to 5



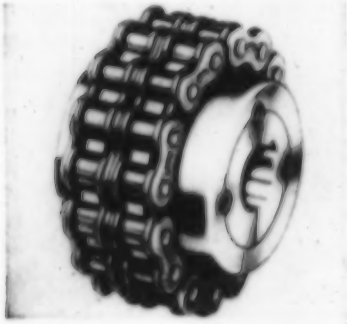
hp, and output speeds range from 1 to 345 rpm. Motor and gear reducer frames are heat-treated aluminum alloy which has high tensile strength and good shock resistance. Light weight of the units makes them suitable for shaft mounting. The hollow shaft is precision bored, with full-length keyway. The low-speed shaft has four oil seals, and the high-speed shaft has two oil seals. The worm-gear is machined gear bronze; the worm is machined from steel and carburized, hardened and ground or polished. **Electra Motors Inc., 1110 N. Lemon St., Anaheim, Calif.**

Circle No. 80, Page 221, for more data

Flexible Couplings 81

compensate for shaft misalignment

Taper-Lock chain type flexible couplings allow sufficient relative movement between the hubs to accommodate slight angular and parallel shaft misalignment. Chain is double-width precision type conforming to ASA specifications. Quick shaft disconnection is accomplished by removing the one coupling pin and unwrapping the chain from the hubs. Sprocket teeth are accurately cut and hard-



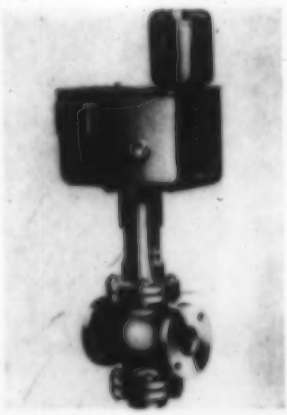
ened. The Taper-Lock bushings, available in desired sizes without reboring, simplify installation on full size or normally undersize shafts. **Dodge Mfg. Corp., Mishawaka, Ind.**

Circle No. 81, Page 221, for more data

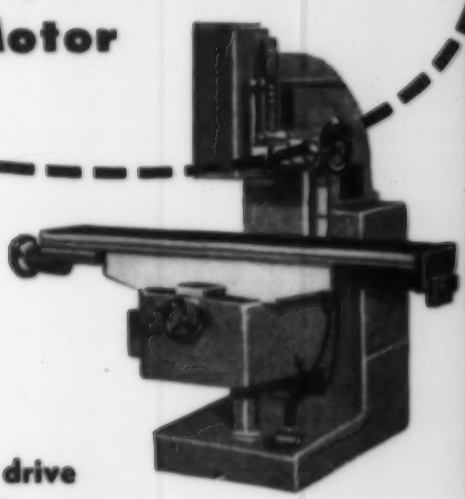
Valve Actuator 82

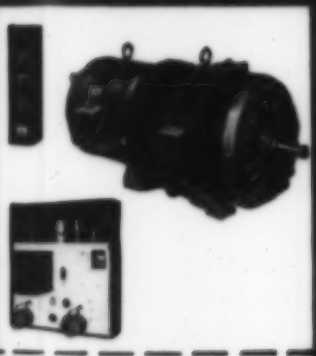
for electronic control systems

This self-contained electrohydraulic valve actuator, for use in electronic control systems, permits applying the electrical output directly to the final control element. The actuator includes a control valve, a hydraulic power source and a proportional positioning mechanism which can be used with existing electronic controllers. Outside connections consist of the signal wires from the controller and an electric power supply. The signal current is applied to a coil having 3000 ohms or more resistance.



You can speed-up your machine-tool operation *when this button* operates a LOUIS ALLIS Adjustable Speed Drive or Special Motor



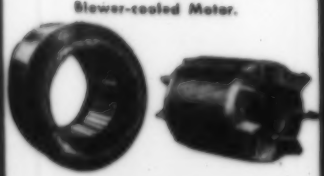


puts precision speed control at the operator's fingertips. ¾ to 75 hp. AC. Uses eddy current clutch to provide speed ranges up to 17:1. Tachometer feedback circuit offers precise speed regulation. Optional features available include dynamic braking, torque control, inching, jogging, multimotor operation and range drives.

5 to 200 hp. Magnetic amplifier and adjustable voltage control provides superior speed regulation from ¼ base speed to full speed. Optional control features include reversing, dynamic braking, jogging, special programming or sequencing, extra wide speed range. Electronic and Static Select-A-Speed Drives also available in smaller horsepower ranges. Speed regulation to ½% in ranges up to 100:1. All operate from AC source.

Blower-cooled Motor.

You don't have to compromise — or take a unit that "almost" does your job when you choose Louis Allis. On short notice you can get a unit exactly engineered and designed for your job. Some of the special characteristics built into Louis Allis motors for specialized machine tool use include high starting torque, high slip, multi-speed operation, and rapid reversing. Other special features may include precision balance, high frequency operation, and special duty cycles. For these or any other special electrical or mechanical modification for machine tool work, see Louis Allis first.



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New precision machine tools call for precision drives. That's where Louis Allis fits into *your* picture. Louis Allis has the exact unit you need because it has the most complete line of motors and drives available to industry.

And if one of Louis Allis's wide range of stock motors doesn't exactly fit your job's requirements, you can get prompt delivery on a unit specially designed to give you the electrical or mechanical characteristics you need. Call your nearby Louis Allis Sales Engineer for motor application assistance on your problem.

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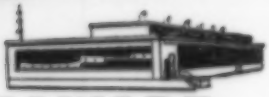
MILWAUKEE 7, WISCONSIN

Silicone O rubber parts produced

by



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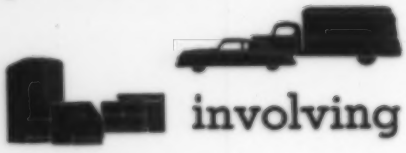

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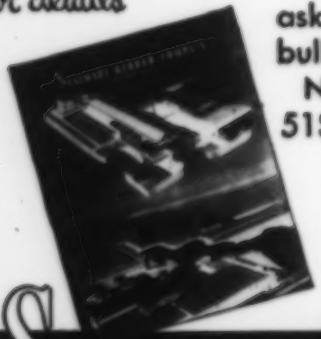


6474-SR

STALWART RUBBER COMPANY

Mfg. Plants in Bedford, Ohio and Jasper, Georgia

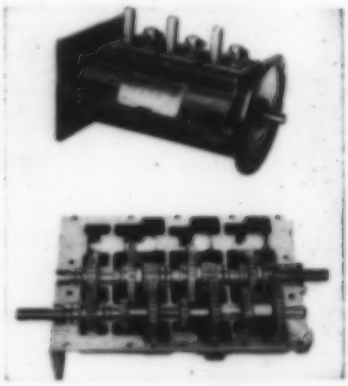
180 Northfield Road • Bedford, Ohio

which moves in a magnetic field. An electrical signal of less than 50 mw is converted into the control valve stroke. The valve moves at a speed of more than 1 ips. Thrusts of 600 lb or more can be handled, and strokes up to 2 in. are available. **Askania Regulator Co.**, 240 E. Ontario St., Chicago 11, Ill.

Circle No. 82, Page 221, for more data

Six-Speed Transmission 83

has overall ratio of 97.5:1



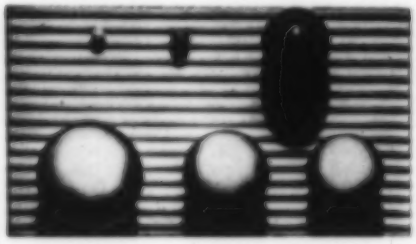
Six-speed transmission with the changes in geometric progression and an overall ratio of 97.5:1, also provides ratios of 1:1, 2.50:1, 6.25:1, 15.60:1 and 39.0:1. Torque capacity is 480 lb-in. Gear shafts are heat-treated alloy steel, and gears are shaved. Revolving shafts operate on antifriction bearings, and a case is provided to hold lubricant. Shifts are made through three shift levers. The case is drilled for pancake type motor mounting. **Western Mfg. Co.**, 3400 Scotten Ave., Detroit 10, Mich.

Circle No. 83, Page 221, for more data

Ceramic Balls 84

fabricated from synthetic and natural ceramics

Precision balls are made to order of synthetic and natural ceramic materials such as aluminum silicate, magnesium silicate, titanium dioxide and aluminum oxides, including sintered sapphire. Resistant to corrosion, abrasion and high temperatures, the balls have high dielectric strength, zero water absorption, low thermal conductivity, and good thermal shock resistance, depending on the material. In



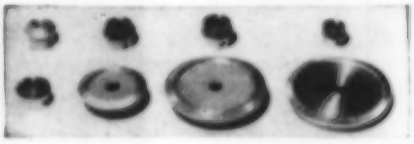
general, compressive strength is over 300,000 psi, specific gravity is 3.5 to 4.0, and hardness is 9 on the Moh's scale. The balls can be furnished in standard or special sizes from ¼ to 4½ in. Accuracy is held to ±0.0002-in. on size and ±0.00005-in. on sphericity in the smaller sizes, and ±0.0005-in. and ±0.0002-in. on the largest size. **Industrial Tectonics Inc.**, 3684 Jackson Rd., Ann Arbor, Mich.

Circle No. 84, Page 221, for more data

Miter and Bevel Gears 85

made of stainless steel or aluminum

Type N precision pin hub type miter and bevel gears are available in No. 303 passivated stainless steel, or chromic acid anodized 24ST aluminum. Cut to AGMA Precision 1 tolerances, gears are available in 48, 64, and 72 pitches



with 20-deg pressure angle, for shaft sizes of ⅛, 3/16 and ¼-in. Gears can have stainless steel setscrews for holding or subdrill hole for fixed pinning. Face widths vary in increments of ⅛, 5/32 and 3/16-in., with ratio ranges from 1:1 to 4:1. **PIC Design Corp.**, 160 Atlantic Ave., Lynbrook, L. I., N. Y.

Circle No. 85, Page 221, for more data

Plastic Rods and Tubes 86

in various sizes and shapes

Clear methyl methacrylate rods and tubes are available from stock in standard or special sizes, fabricated from Rohm & Haas Plexiglas and Du Pont Lucite. Rods ⅛ to ¾-in. thick are available in 6-ft lengths; ⅞ to 1¼-in. rods are

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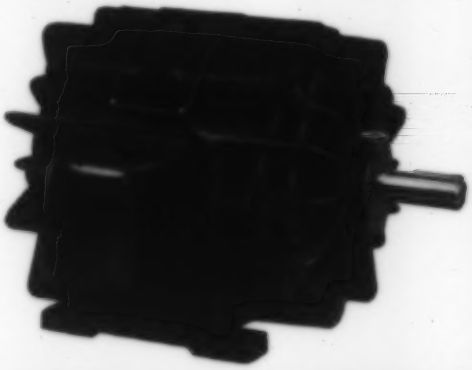
MOISTURE-PROOF!

TWO NEW "DIEHL MOTORS FOR Air-Over-Motor" APPLICATIONS



Type "DAF" Motor (Dust Fan-Cooled)

Type "DAF" Motor (Fan-Cooled)

Tops in Quality — Competitive in price!

When you buy or specify motors for fans, blowers, unit heaters, air conditioners, cooling towers or dehumidifying systems *don't overlook* these two new standard or custom-designed Diehl Totally-Enclosed Motors.

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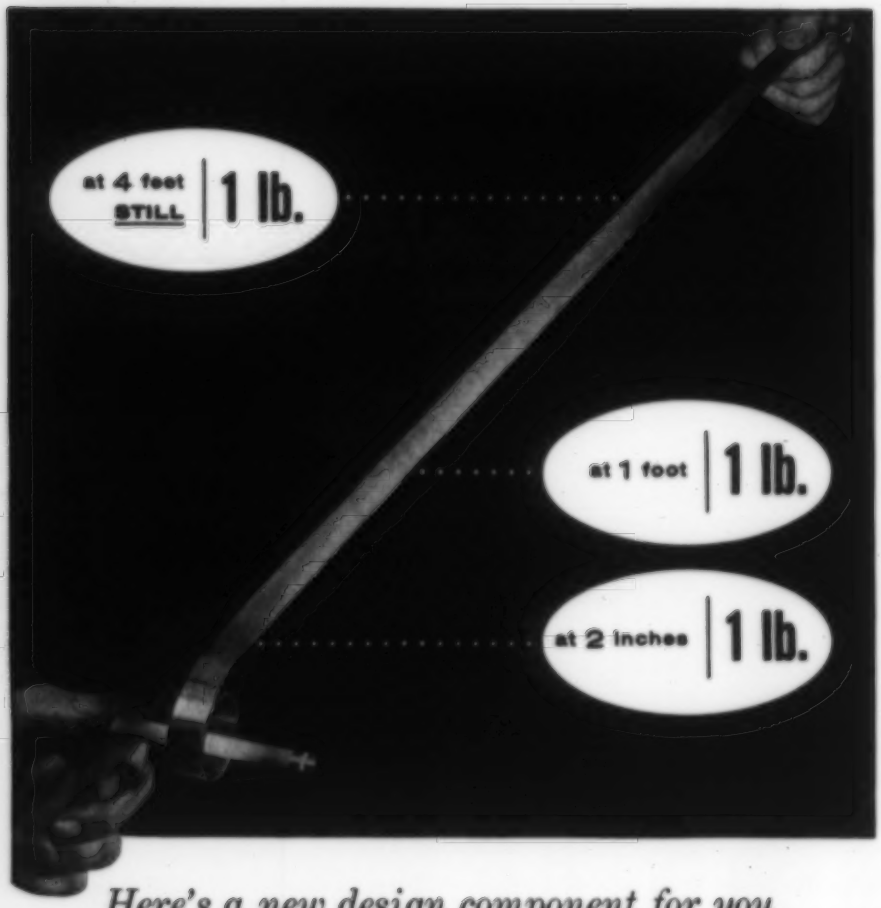
INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES



Here's a new design component for you

THE FIRST CONSTANT FORCE SPRING!

Do *you*, too, want to simplify a product design problem — reduce weight, miniaturize, cut cost, *improve* the product, or even create a *new* product?

Can you use a *constant force spring* that's *not only a spring* but also a *motor*, a *counterbalance*, a *clamp*, *clip*, *slot closure*, and anything else *you* might make it?

The Hunter Neg'ator *constant force* spring upsets all previous spring principles. In addition to a zero gradient, negative or slightly positive gradients are also possible with the Neg'ator.

Hundreds of ingenious engineers have already used the Neg'ator spring to obtain—

- Tremendous extensions—over 30 times the original size—with no appreciable force build-up.
- Driving torques with longer duration and *no* heavy wind-up.
- Full force available from the very beginning of the stroke right up to the completion of the return stroke.
- The equivalent of a dead weight (in a range sufficient to counterbalance a mouse or a man) in one handful.
- Many other unusual characteristics.

Are *you* ready to learn more about this remarkable new spring element? We're ready to tell you. Just ask for our new bulletin, "The Hunter Neg'ator Spring". This bulletin describes the Neg'ator force characteristics, and its variety of forms and applications. Also included are many "thought provokers" for applying this promising new mechanical element.

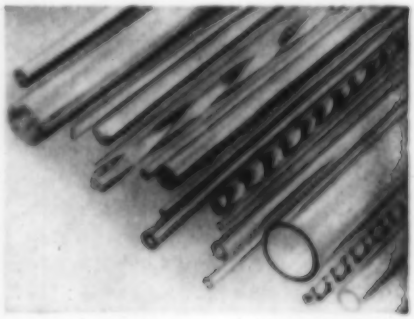
THE HUNTER **neg'ator** constant force spring

HUNTER SPRING COMPANY

Lansdale, Pennsylvania . . . near Philadelphia

SPRINGS • STAMPINGS • TEST APPARATUS

New Parts



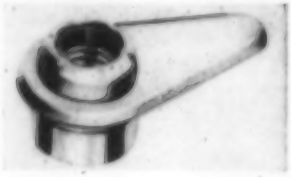
made in 4-ft lengths. Tubes are 6 ft long and have tolerances of ±0.010-in. up to ⅞-in. diam and ±0.015-in. in sizes over 1 in. Half-round, square and twisted rods are also available. **Ace Plastic Co.**, 91-36 Van Wyck Expressway, Jamaica 35, N. Y.

Circle No. 86, Page 221, for more data

Self-Wrenching Locknut 87

in ¼-28 to 9/16-18 sizes

Integral lug on this type N2603 self-wrenching locknut prevents it from rotating when bolt is tightened by bracing itself against any adjacent surface. Made of steel



with a cadmium plated finish, this removable fastener has a red nylon insert which provides the means of locking. Thread sizes of the six nuts in this series are ¼-28, 5/16-24, ⅜-24, 7/16-20, ½-20 and 9/16-18. **Elastic Stop Nut Corp. of America,** 2330 Vauxhall Rd., Union, N. J.

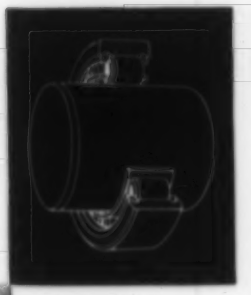
Circle No. 87, Page 221, for more data

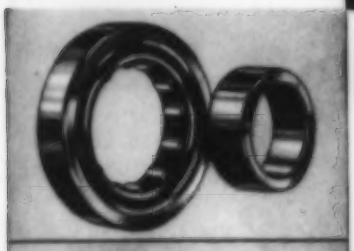
Thermocouples 88

operate with high thermal conductivity

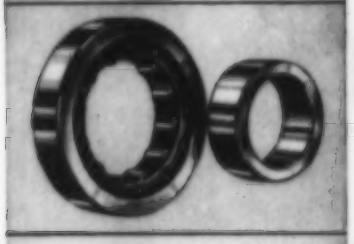
Self-contained, pressure-sealing, spring-loaded thermocouples insure positive contact for high thermal conductivity. Uses include checking bearing and surface temperatures. Construction provides fast response. Sealing method prevents the entry of foreign matter into the system and seals internal vacuum or pressure to 200 psi. Fit-

4 types with separable inner races

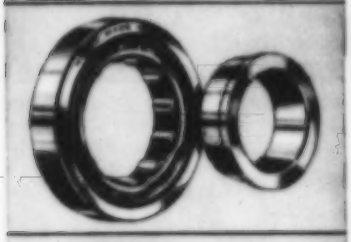




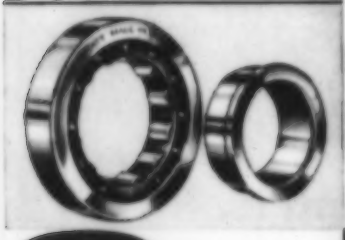
A-TS Single row, straight inner race, rollers retained by cage, end rings or retainment rings recessed in outer race, inner race completely separable.



A-WB Single row, straight inner race, double flanged outer race, inner race completely separable.

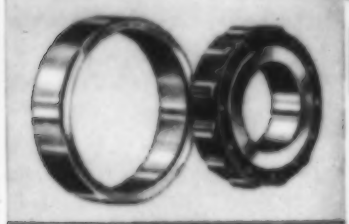


R-YS Single row, single flanged inner and outer races, rollers retained by flange and single retainment ring recessed in outer race, inner race completely separable.

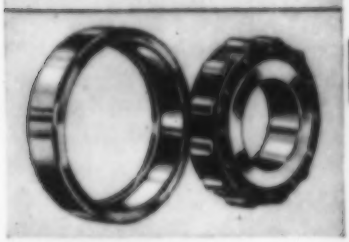


R-WB Single row, double flanged outer race, single flanged inner race, inner race completely separable.

2 types with separable outer races

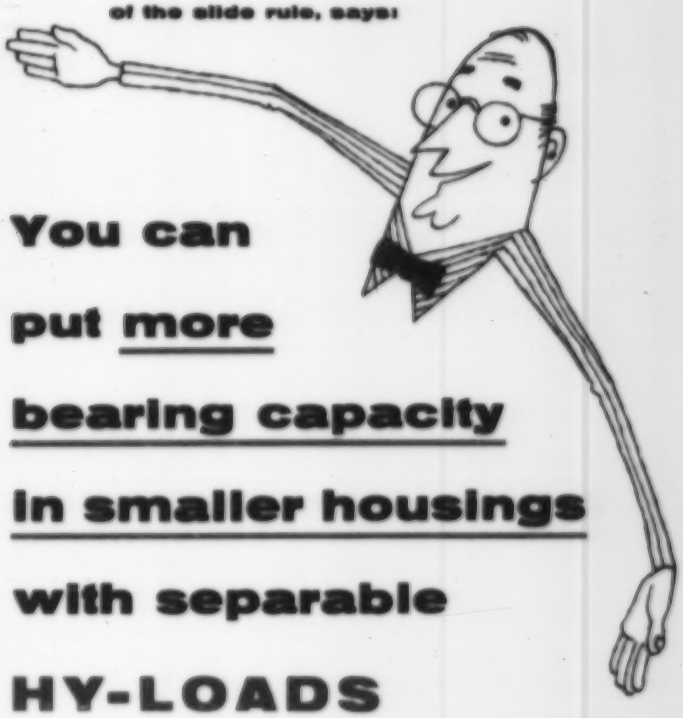


BU-Z Single row, double flanged inner race, straight outer race, outer race completely separable.



BU-L Single row, double flanged inner race, single flanged outer race, outer race completely separable.

HY POTENUSE, the sage of the slide rule, says:



You can put more bearing capacity in smaller housings with separable HY-LOADS

As today's trend toward more compact design exerts increasing pressure for space conservation, more and more engineers are recognizing the inherent design and assembly advantages of HYATT Hy-Load *separable* straight cylindrical roller bearings.

Where bearing operating surfaces can be of suitable hardness and finish, *the separable race can be completely omitted*, and rollers operated directly on the shaft or in the housing bore. Thus adequate bearing capacity can be *retained* when housing size is reduced, or bearing capacity can be *increased* without enlarging the housing.

HYATT offers 6 major types of Hy-Loads with separable races, as detailed at the left. For further information consult HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer. He will gladly help you plan to take maximum advantage of these extraordinarily versatile members of the HYATT Hy-Load family. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT

ROLLER BEARINGS

NOSCO "CAN DO"

Other injection molders said . . . "Impossible"

We took a second look

It was a complex air-conditioning grille—no question about that. But impossible? —our ingenious engineers didn't think so. We helped with the plastic-part design . . . developed a special molding material . . . designed a mold with almost 90 feet of parting line . . . then built the mold. We molded the several plastic parts on our modern pre-plasticized presses, inspected, decorated, and conveyor-line assembled. Nosco packed and palletized the finished parts according to our customer's needs—shipped the initial desired quantity as scheduled, and the rest were stored in the warehouse section of our 227,000 sq. ft. plant, awaiting releases.

Not every job we do is an "impossible" one. But Nosco "Can Do" can make any plastics problem seem easier. We've proved it over and over again. Let Nosco prove it to you on your next plastic part.

NOSCO plastics, inc. • erie 2, pa.

World's largest injection molding plant

For other case histories—and a glimpse of the Nosco plant and facilities, send for the free 12 page brochure: "How the Nosco Plant Works To Produce Your Needs In Practical Plastics."

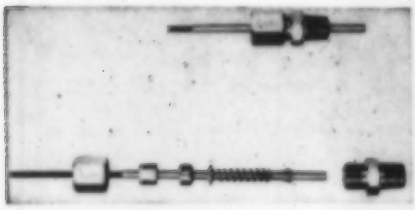
Nosco Plastics, Inc.
Erie 2, Pa.
Please send me ( ) copies of the Nosco Brochure.

Name: _____

Title: _____

Address: _____

Firm: _____



tings and tubes, which are available in lengths to meet specific requirements, are type 303 stainless steel. Either iron or copper-constantan calibrations are available. Standard pipe thread connection is ⅛-in. IPS. **Conax Corp.**, 7811 Sheridan Dr., Buffalo 21, N. Y.

Circle No. 88, Page 221, for more data

Subminiature Gear Head 89

has adjustable slip clutch

Measuring 0.937-in. diameter, this subminiature gear head adds ⅝-in. to length of size 10 motors in the 26.4:1 reduction ratio. It is available in all practical ratios. The

unit contains an internal adjustable slip clutch, has backlash of less than 30 min and weighs 1¼ oz. Stainless steel housing has a black passivated finish. Gear clusters and pinions are stainless steel, and ABEC Class 5 bearings are used. **Bowmar Instrument Corp.**, 2415 Pennsylvania St., Ft. Wayne, Ind.

Circle No. 89, Page 221, for more data

Low-Pressure Pumps 90

in flow ranges up to 55 gpm

Series of neoprene rubber impeller pumps from ⅜ to 1¼ in. iron pipe size and with flow ranges to 55 gpm is intended for transferring any liquid that does not affect bronze or neoprene. Pressures range up to 30 psi. Applications include appliances, engine cooling, refrigeration and industrial coolant

(*Continued on Page* 242)

Eye

Each year more and more companies use super-slow-motion movies (up to 3200 pictures a second) to solve design, production, and maintenance problems involving motion too fast for the human eye to follow. Some even use such movies as a sales tool.

Kodak has just introduced a new film for this work, far more sensitive than any hitherto available. It is already contributing heavily to the achievements of specialists in the use of high speed movie cameras.

But there is one high speed camera on the market so simple that a man can use it successfully without taking time out to become a specialist. It is called, simply, the Kodak High Speed Camera. For full details about it, write *Graphic Reproduction Division...*

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the Kodak
***HIGH SPEED* Camera**

Kodak

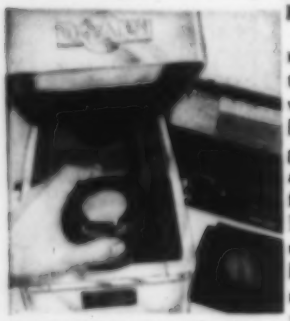
Reynolds
ALUMINUM REPORTER
★ ★ ★ Twentieth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

ALUMINUM EXTRUSION SOLVES SCRAP PROBLEM

Aluminum's Easy Machinability Ideal for Short-Run Production of DoALL Monolight

DoALL Monolights are used to check the accuracy and measure the finish of gauges and lapped parts to within millionths of an inch. These generators produce Monochromatic light of a single, known wavelength which enables operators to detect incredibly small surface irregularities by observing reflection patterns.

These precision instruments are produced in short-run quantities. These limited production runs make cast and machined aluminum the most economical material to use, cheaper than stamping or sheet metal fabrication. Finishing operations, too, are easier, and trim is given its shiny appearance simply by buffing.



New DoALL 2" utility Monolight. Non-magnetic aluminum permits use on magnetic chucks.

Other aluminum advantages, light weight combined with great strength, are important factors, as Monolights are used at work benches, and in regular inspection procedures they are frequently moved from place to place. DoALL Monolights vary in size from 2" to 20". The 2" instrument is often used on magnetic chucks of surface grinders to check surface finishes. Here aluminum provides complete magnetic shielding for the Monolight's transformer. Life of the Monolight instruments is longer because of aluminum's non-rusting and corrosion resisting characteristics.

The aluminum advantages considered by DoALL, plus its excellent heat and light reflectivity, high electrical and thermal conductivity indicate aluminum's use in a broad variety of applications.

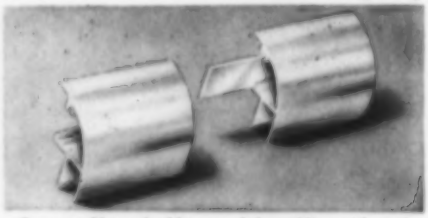
For applications in which the easy machinability of aluminum is a consideration Reynolds offers a special technical handbook, "Machining Aluminum Alloys." This 124-page book covers tools, speeds and feeds, plus information on operations including automatic screw machining. Single copies of "Machining Aluminum Alloys" are free when requested on your business letterhead. See address below.

A. A. F. Uses Aluminum in Filter, Fan, Coil, Grille, Duct and Damper of Classroom Unit Ventilator

The ability of aluminum extrusions to economically provide intricate cross-sections to close dimensions solved a problem and supplied a fabricating advantage to American Air Filter Company of Louisville, Kentucky.

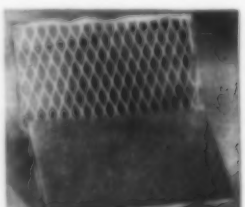
The problem solved by extrusions involved the moulding along the top of the multi-unit Herman Nelson Classroom Unit Ventilator, shown at right. This piece was formerly rolled from steel and had to be folded down at each end to provide for fastening adjacent units. Bending frequently resulted in wrinkling and wrinkled pieces had to be scrapped.

Redesigning the moulding to a 6063-T42 aluminum extrusion offered a simple joining solution by including a locking strip track. As shown below, an aluminum locking strip



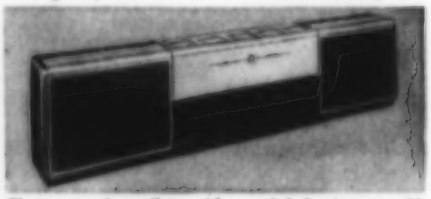
Scrap problem solved by extruded moulding with track for short locking strip, set screws.

is inserted in the track, at the ends of adjacent moulding sections. The strip is then secured by a screw in the lower track of each moulding. Only an extrusion could make this track possible in the intricate cross section of a single piece moulding. And the dimensional accuracy of Reynolds Aluminum extrusions provided perfect alignment of the butted ends resulting in a clean, accurate, strong joint at a lower cost than ever before.



Double leg extruded aluminum angle frames retainer for removable glass filter.

A renewable air filter with a lightweight aluminum frame and face was developed as a low maintenance feature of the same classroom unit ventilator. The frame is extruded, 6063-T4 aluminum angle with a double leg on one side. After notching, the angle for each of the two frame elements, is formed around a 1½" mesh, expanded, flattened aluminum face sheet, so that the sheet fits into the channel formed by the twin legs of the angle. Frame corners are heliarc welded; face is tack welded to the angle; and the two frame halves joined by spot welded hinges.



Classroom unit ventilator with extruded aluminum moulding across top, front edge.

Since the air intake grilles and ducts, and the squirrel cage fans of the classroom ventilator frequently handle damp, outside air, Reynolds Aluminum's rustproof quality is of special value in these applications. In addition, the light weight of aluminum greatly simplifies and reduces the cost of balancing the fans, and makes airstream actuation of a recirculating damper most efficient. Fan center disc, rims and blades are all made of 3003 aluminum alloy in H16, H14 and H18 tempers respectively, and the hub is 2011-T3 aluminum screw machine stock. Assembly is by upsetting blade ends against rims, center disc against blades, and hub against center disc. Duct, grille, and damper are all formed from 1100-H16 aluminum sheet.

Aluminum simplifies balancing of squirrel cage fan, prevents moist air rust.

Because of the heat transfer efficiency of aluminum and its extremely favorable price and supply advantage over copper, fins for heating coils in the classroom unit ventilator are made of 1100 alloy aluminum in the 0 temper.

To improve your products with aluminum, Reynolds Styling and Design departments will be glad to work with your engineers. As American Air Filter has with their application of aluminum, you may be able to increase efficiency and sales appeal without increasing cost.

Reynolds has prepared a 138-page handbook, "Designing with Aluminum Extrusions." Single copies are free when requested on business letterhead. Also available is a complete index of Reynolds technical literature and films. See address below.

WRITE REYNOLDS METALS COMPANY, P. O. BOX 1800-HL, LOUISVILLE 1, KENTUCKY

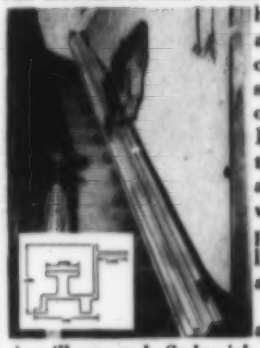
(Advertisement)

Printed in U.S.A.

Single Aluminum Extrusion Replaces 3 Element Assembly in Sedgwick Elevators

Sedgwick Machine Works of Poughkeepsie, N. Y., recently switched to one of the largest aluminum extrusions produced for commercial use, for the rail on which its Stair-Travelor home elevator operates.

Previously, Sedgwick used a heavy metal rail assembled from a standard 5″ x 5″ x ½″ hot rolled angle and two pieces of cold rolled bar stock. One piece of bar stock was 1″ x 1¾″, and for the top of a Tee, a ½″ x 3″ piece was used. These pieces had to be laid out, machined and welded.



By using the aluminum extrusion illustrated, Sedgwick simplified layout and eliminated welding and machining costs as well as the cost of combining sections to make one long rail. In addition, desirable new features included in the extrusion were not feasible in the welded assembly. And corrosion, which had occurred when the part was made of ferrous metal, has been eliminated completely.

Extruded aluminum, means a considerable per foot saving in manufacturing and installation costs, and customers save on F.O.B. freight charges due to aluminum's light weight.

Many companies are now using aluminum extrusions to reduce their costs. To acquaint you with their possibilities and low cost of dies, Reynolds offers a 138-page handbook, "Designing with Aluminum Extrusions." Single copies free when requested on business letterhead. See address below.

New Method For Making Aluminum Tube From Strip

Reynolds Metals "Technical Advisor" No. 29, details a new low-cost method for making aluminum tube directly from strip. A fabricator can make his own tube in his own plant and obtain many important economies. The new method is claimed to greatly extend applications of aluminum tube, as it easily handles diameters from ½″ to 2¼″ and wall thicknesses from 0.020″ to 0.083″.

In this method, strip is formed into a tube by a series of forming rolls. Tube then passes through a welding head where high-frequency current (450,000 cycles) is focused to heat by electric induction only the very edge of the strip at the exact point where the edges are butted together. No metal is added. Other rolls now squeeze out the melted metal, leaving only an extremely narrow weld zone. This eliminates weak cast metal so the weld zone has strength equal to that of unwelded tube. The weld is made at a rate of 100 feet per minute or more. The weld is exceptionally strong.

This new process is claimed suitable for working the non-heat-treatable aluminum alloys, 5050 and 5052. High yield-strength tube in these two alloys have never before been available as temper drawn tube.

If you would like more complete information you may receive free this and future issues of the Reynolds Technical Advisor by requesting it on your business letterhead. See address below.

Stationary Whirlybird Drives Away Smog, Fog and Frost

The odd-looking structure pictured below owes its existence almost entirely to the unique properties of aluminum. It is the "Weather-Master" fog and frost control tower, manufactured by Diesel Power Inc., Greenville, Pennsylvania.

Operating on the helicopter principle, the Weather-Master pulls warm, dry upper air down against an adjustable diffuser and spreads it evenly in all directions. A special, horizontal propellor is driven by a vertically mounted electric motor.

Each tower replaces several of the smudge pots now used to protect fruit and tender plants against frost. They also relieve fog conditions at airports. There are 20 agricultural applications and industrial uses.

Because the Weather-Master stands 30 feet high, it must be constructed of a metal that is both strong and light. Light weight is also an advantage in shipping and erection. The moist air the Weather-Master is designed to dispel cannot rust aluminum. Painting is never necessary.

The tower is a 10″ od extruded tube with a .188″ wall of 6061-T6 aluminum. Other structural members are 6061-T6 aluminum angles. Diffuser is 3003-H14 aluminum sheet. Base and motor mountings are aluminum castings.

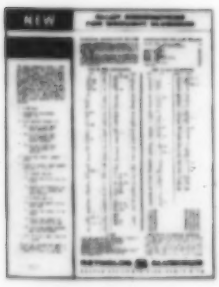
If aluminum can benefit your products, Reynolds engineers will be glad to assist you on design or redesign. Or write for the 130-page handbook, "Aluminum Structural Design." Free when requested on business letterhead. See address below.

WHAT'S NEW

A Quick Look at New Reynolds Aluminum Products and Applications

Wrought Aluminum Alloy Designation Chart Available

A special chart is available from Reynolds Metals Company, showing old and new alloy designations for wrought aluminum. The new designations are those put into effect by the Aluminum Association on October 1, 1954.



The Reynolds chart is in two sections—old to new conversion, and new to old conversion. In addition it is footnoted with both general and specific data. A review of the Temper Designations system in effect since 1947 is also included.

For copies of this convenient chart in 8½″ x 11″ and 17″ x 22″ sizes, write to Reynolds Metals Company at the address below.

Reynolds Offers New R-2003 Calcined Alumina

Calcined alumina of top ceramic quality at regular commercial prices has been announced by Reynolds Metals Company.

R-2003 calcined alumina contains fewer impurities and less water, which reduces dusting and minimizes shrinking. It contains only traces of such impurities as oxides of iron, silicon and titanium.

The new calcined alumina is highly resistant to thermal and mechanical shock, and transmits these properties to the finished product. Applications of R-2003 alumina range from abrasives to use in refractories for lining tanks or furnaces. For further information, write to Reynolds at the address below.

Reynolds Aluminum Foil Finds New Packaging Application

Added to the countless food packaging uses for Reynolds Aluminum foil is a new foil-paper material for multiwall bags for bulk packaging of hygroscopic chemicals, resins, or other products requiring high moisture protection.

One company is using 50-pound foil lined bags for packaging its animal feed, and Reynolds is using a 100 pound bag for packaging and shipping activated alumina.

Names of foil lined bag manufacturers are available on request.

Consumers Look For Reynolds Design Seal

This "Designed in Reynolds Aluminum" seal is familiar to millions of homes, thanks to extensive television advertising. To consumers it means products manufactured with highest quality aluminum — makes buyers out of shoppers. For details on how your company can qualify for this seal, write Reynolds Metals Company at the address below.

FOR COMPLETE INFORMATION ON THESE OR ANY OTHER REYNOLDS ALUMINUM PRODUCTS, write to Reynolds Metals Company, P.O. Box 1800-BL, Louisville 1, Kentucky

Flame-Sprayed

MH CERMET*

***New* High-Temp**

Oxidation Resistance

NEWS YOU SHOULD KNOW . . . Now longer life, greater value can be derived from your components of mild steel, stainless steel, or other alloys. Easily flame-sprayed Metal Hydrides' new Cermet of nickel-magnesium oxide* resists high-temperature oxidation and provides low thermal conductivity and high-temperature erosion resistance.

Metal Hydrides' metallurgical engineers will be happy to give you more information, without obligation. Call, wire or write today.

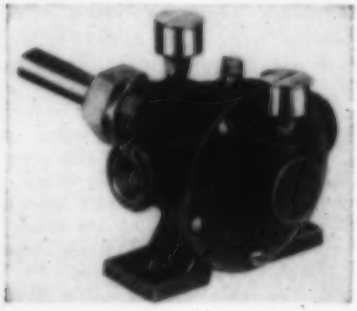
Pioneers In Hydrogen Compounds

Metal Hydrides
INCORPORATED

1207 CONGRESS STREET, BEVERLY, MASSACHUSETTS

New Parts

(*Continued from Page* 239)



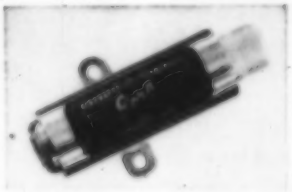
pumping. Pump is made of bearing bronze with easily replaced neoprene impeller keyed to stainless steel shaft. It will operate in either direction at high or low speeds and will pass small particles or abrasives without jamming. Unit is self-priming to about 15-20 ft when wet. Speeds range from 100 to 1750 rpm. Pumps operate with standard high starting torque motors from ⅓-hp and up. **American Machine Products Inc.**, 172 Centre St., New York 13, N. Y.

Circle No. 90, Page 221, for more data

Pressure Switches 91

for 100 to 12,500-psi range

Weighing 4 oz, this pressure switch can be set to respond to hydraulic or pneumatic pressures in range of 100 to 12,500 psi. It will



withstand severe vibration, acceleration and adverse environmental conditions. Applicable to aircraft and industrial systems, it is adaptable to various mountings or envelope specifications. **Gorn Electric Co. Inc.**, Aircraft Controls Div., 845 Main St., Stamford, Conn.

Circle No. 91, Page 221, for more data

Magnetic Clutches, Brakes 92

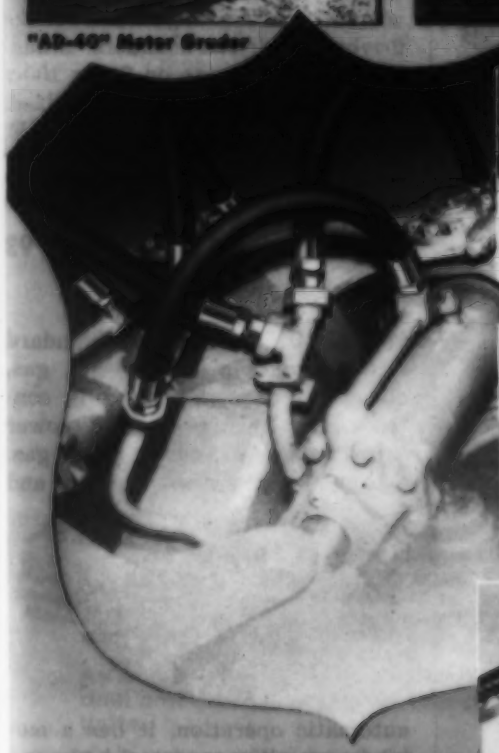
miniature units operate electrically

For applications requiring a simple, miniature disconnect or non-chattering brake, size 100 electromagnetic clutches and brakes can also be used for intermittent duty

Eastman HYDRAULIC HOSE ASSEMBLIES DELIVER MOBILE POWER *for* ALLIS-CHALMERS

"AD-40" Motor Grader

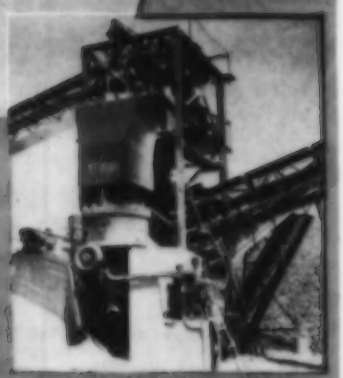
"TS-300" Motor Scraper



Eastman Hydraulic Hose Assemblies used on steering ram of Allis-Chalmers TS-300 and TS-360 Motor Scraper. Also used on TS-200 Series to control steering, plus apron, ejector and bowl action—applying down pressure when loading equal to the weight of the scraper—38,560 lbs.!

ALL-CROP Harvester

"WD-45" Tractor



HYDROCONE Crusher

GLACIERS NEVER HAD IT SO EASY . . .

The millions of years required by the glaciers to scour and alter the earth diminish to mere minutes when Allis-Chalmers earth moving and grading machinery go to work. Many of these mighty machines owe much of their ease of operation and maneuverability to hydraulic power—delivered through EASTMAN Hydraulic Hose Assemblies.

TODAY'S FARM YOUTH NEVER BORN "30 YEARS TOO SOON"

Milestones in farm mechanization are marked by Allis-Chalmers farm machinery. Pioneering in many farming innovations resulted in such exclusive firsts as the ROTO-BALER, ALL-CROP Harvester, Rear-Engine Tractor—Power Shift Wheels, SNAP-COUPLER and Hydraulic Traction Booster. Much of the operation and control of this world famous line of farm machinery is done through hydraulic power—also applied through EASTMAN Hydraulic Hose Assemblies.

NATURE NEVER CRUSHED ROCK LIKE THIS . . .

Hydraulic power on the HYDROCONE crusher affords "one man, one minute" product size control. It provides a rapid and convenient means of raising or lowering the crushing head. It permits compensation for wear and facilitates emptying the crushing chamber in case of power failure or for the quick release of uncrushable materials. Allis-Chalmers pioneered in this type of crusher—as EASTMAN pioneered in Hydraulic Hose Assemblies.

TURN TO EASTMAN for *your* **Hydraulic Hose Assemblies, too. Whatever your requirements, always get your first recommendation from EASTMAN . . . *first in the field.* Exclusive designs, advanced engineering, unequalled production facilities and efficiency—mean unequalled economy, performance and constant customer satisfaction for you.**

Eastman

first in the field

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

EASTMAN MANUFACTURING CO.
Since 1914
Dept. MD12, Manitowoc, Wisconsin

WRITE *for free Catalog 101 on Eastman Hose Assemblies*

Use FAIRFIELD GEARS

the POWER and PERFORMANCE OF YOUR PRODUCT

There's hardly a power driven machine built that doesn't depend on gears for its get-up-and-go—its productivity—and very often *its reputation*.

No wonder, then, why more and more manufacturers insist on Fairfield Gears for their QUALITY—and also for their mass-production ECONOMY.

No matter what type or size of gears you require, it will pay you to check with Fairfield first. Take advantage, too, of Fairfield's helpful engineering services. *Your inquiry will receive prompt attention.*

Ask for interesting, illustrated bulletin.

Fine Gears Made to Order

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(Follows Type). Sizes from 1½" to 15".

SPIRAL BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

ZEROL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS—Lengths to 52". Diameters from 1" to 6".

DIFFERENTIALS—10,000 to 300,000 inch pounds capacity.

Note: All sizes above are approximate.

FAIRFIELD MANUFACTURING CO. for FINE GEARS

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New Parts

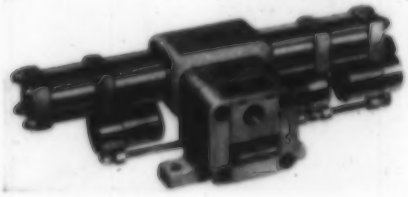
in slip applications. They weigh 2½ oz, measure less than 1-in. in diam and consume 2w of power. Torque rating is 30 oz-in. Units can be used at speeds to 4000 rpm, and their response time is 10 to 15 milliseconds. Design allows for considerable misalignment of the driving and driven members. Standard models operate on 28 or 100-v dc; other voltages can be specified. **Dial Products Co.**, 9 Avenue E, Bayonne, N. J.

Circle No. 92, Page 221, for more data

Power-Operated Valve 93

for air, gas, oil or water

Model PON valve is a standard four-way disk valve for air, gas, oil or water service and is controlled by a three-position power attachment operated by air or gas. Designed for remote control and



automatic operation, it has a molybdenum alloy semisteel body and chrome plated surface in the body for smooth action. Integral disk and stem provide rigidity. **Ledeen Mfg. Co.**, 1600 S. San Pedro St., Los Angeles 15, Calif.

Circle No. 93, Page 221, for more data

Selenium Rectifier 94

compact, dual-purpose unit

Type 60-9150 selenium rectifier is basically a voltage doubler stack. One can be used as a doubler, and two units can be connected as a single-phase, full-wave bridge. The rectifier is usable where hum caused by normal operation of ac relays is objectionable. Two rectifiers connected in a single-phase, full-wave bridge circuit, will de-

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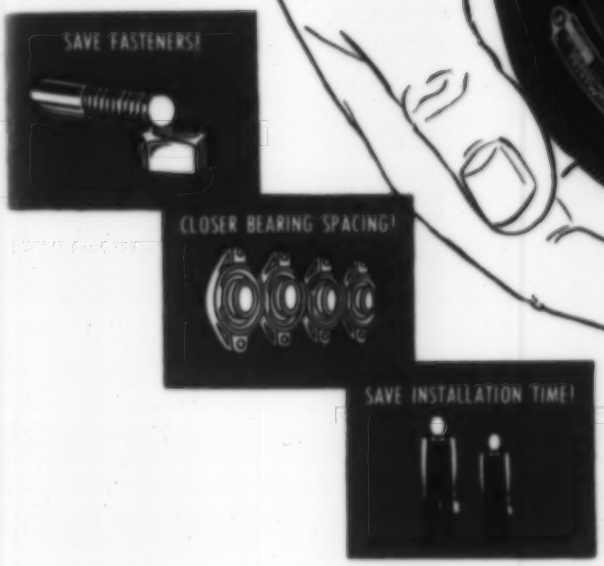

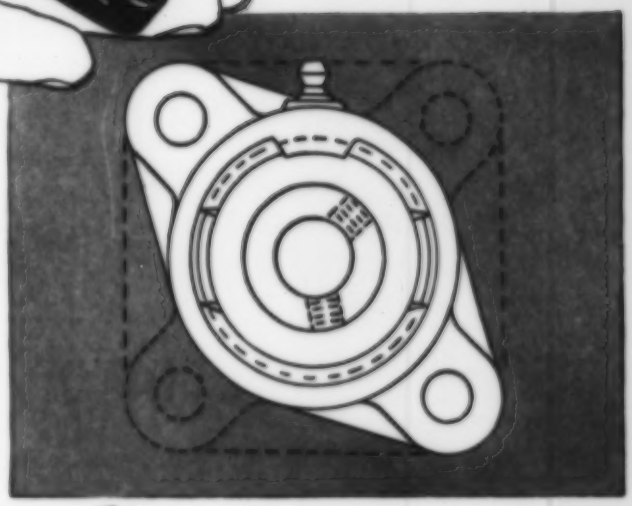

Check these facts!

- **Cuts installation costs by eliminating two fasteners and punching or drilling operation required for two mounting holes.**
- **Permits closer bearing spacing on multiple shaft installations.**
- **As a replacement bearing unit fits the diagonal bolt centers on present four-bolt flange units.**
- **Carries the same load rating for a given shaft size as four bolt units.**
- **Retains all patented design features of SEALMASTER Bearing Units—Zone Hardening, Self-Alignment, Locking Pin & Perimeter Dimple and Labyrinth Seal.**
- **Available in shaft sizes from ½ to 2 15/16 inches.**

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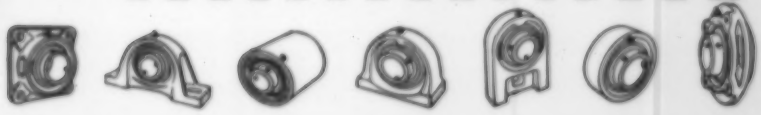
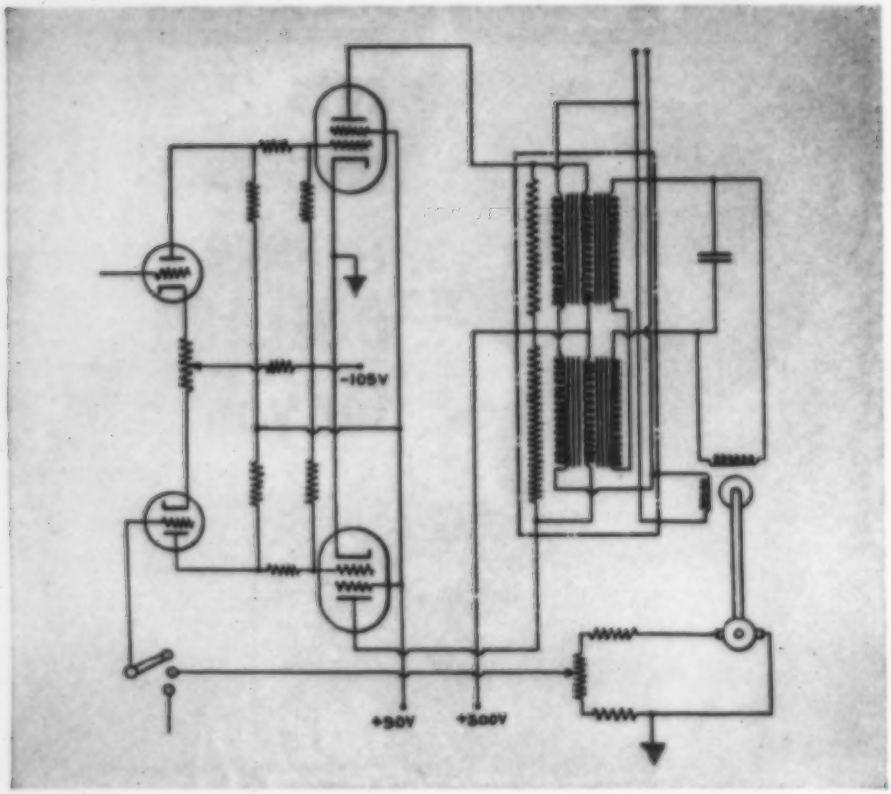


SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. • 18 RIDGEWAY AVE., AURORA, ILLINOIS

SINCE 1915 LEADERS IN AUTOMATIC CONTROL



Servo Motor Control System

Most engineering ingenuity concentrates not on basic principles, which are relatively simple, but on the fine details that make the difference between good and poor design, between high and low cost, or between efficient and inefficient component arrangement. For instance, the motor control system patented by the Ford Instrument Company. The purpose of the system is to provide a sensitive control system to make an induction motor respond accurately to a relatively small reversible input signal. This system employs saturable-core transformers to combine the sensitivity of vacuum tube amplifiers with the high power-carrying capacity of saturated-core devices. This also facilitates the problem of matching the motor impedance with that of the amplifier.

In the circuit shown the first pair of tubes act as a phase inverter, with the control signal applied to the grid of one inverter tube. The feedback signal, produced by a d-c generator coupled to the controlled motor, is applied to the inverter tube. The output of the inverter is the signal of the servo loop. The second pair of tubes acts as a driver-stage for the saturated transformers that supply one winding of the controlled two-phase induction motor; the other motor winding is connected to the power line.

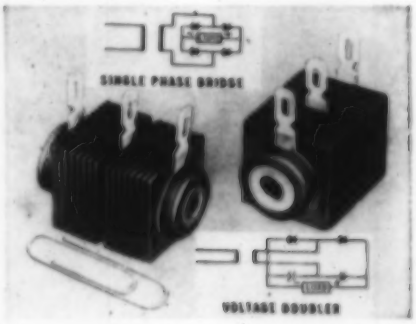
This is typical of the things Ford engineers do . . . every day. If you have a control problem it will pay you to talk to the Ford Instrument engineers.

83

FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

ENGINEERS
of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

New Parts



liver approximately 180 v dc at 0.10-amp for an rms voltage input of 230 v. As a voltage doubler, the unit will deliver 50 ma connected to a maximum ac input of 175 v rms. The rectifier occupies space of 21/32 x 1 1/16 x 1¼ in. and can be mounted with a No. 8 (0.164-in.) machine screw through the hollow brass eyelet. Two of the small units can be mounted or molded in a dc relay housing. **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

Circle No. 94, Page 221, for more data

Clevis Yokes 95

in plain, tapped and threaded types

Wide range of standard sizes in plain, tapped and threaded types is available in this line of clevis yokes. Usable in a variety of applications for attaching to threaded

or tapped linkages, the yokes are forged with holes reamed and faced-off parallel inside and outside of the yoke ends. **Jergens Tool Specialty Co.**, 712 E. 163rd St., Cleveland 12, O.

Circle No. 95, Page 221, for more data

Check Valve 96

for use with ⅜-in. piping

Gasket-mounted, pilot-operated check valve for use with ⅜-in. piping is of spring-closed poppet type construction. Spring closure provides uniform operation in any mounting position. The valve has

Giant battery cases weigh less... because they're made with DYLENE* POLYSTYRENE

BIG battery cases like the one pictured are used in communication centers and for emergency purposes. The cases were formerly made from rubber. Today these battery cases are made from Dylene polystyrene. They weigh approximately 15 pounds and will give long, dependable service.

Dylene polystyrene is being used to replace glass, metal and rubber in many industrial applications. By choosing the right type of Dylene plastic you can get such qualities as high impact resistance, low water absorption, dimensional stability, and high heat distortion resistance. Parts made from this lightweight plastic can be molded in any shape you need . . . *at low cost.*

Koppers engineers will give you technical assistance in selecting the proper Dylene polystyrene to improve your product or reduce production costs. Write to us for more information.

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Koppers Plastics

Manufacturer: The Electric Storage Battery Company, Exide Industrial Division, Philadelphia, Pa. This 13¼" x 14½" x 19½" battery case, molded by the Mack Molding Company, Arlington, Vt., is believed to be the largest single mold shot ever made.

KOPPERS

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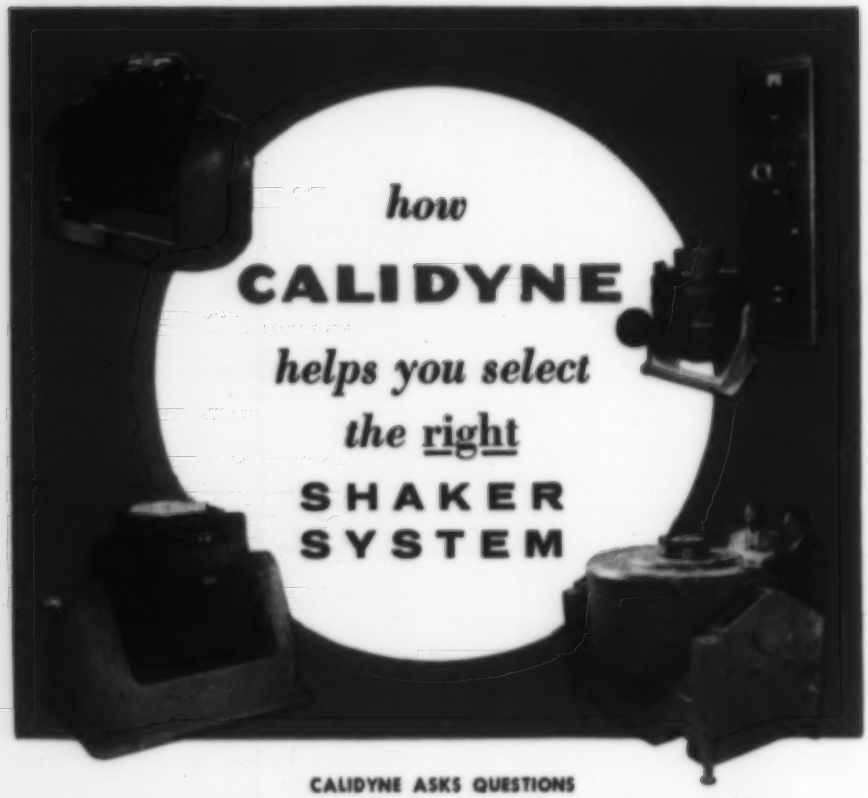

CALIDYNE ASKS QUESTIONS

When you inquire about Calidyne Shaker Systems, you're asked "What *type* of vibration testing is required — conventional environmental testing? Fatigue testing? Structural response determination? Mechanical noise reduction?" Further, "What are your present, and anticipated, requirements for force, frequency, and stroke?" In this way, Calidyne can recommend the equipment which will provide *maximum* usefulness for your investment, with as much flexibility as possible for future needs.

CALIDYNE DELIVERS

To meet your requirements, Calidyne offers complete Shaker Systems ranging in force output from 25 to 12,500 pounds. Systems consist of one or more electrodynamic Shakers, a rotary or electronic power supply, a control console and various optional accessories for monitoring, measuring or automatically cycling tests. Calidyne Shakers feature greater useful force output through lighter armatures, true linear armature motion, rugged construction. Certain Calidyne power supply units, also, will operate Shakers of widely different force outputs. Any accessory may be added to a basic system at any time, without costly revamping or modification.

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For competent help in solving your vibration testing problems, or technical data on any Calidyne Shaker System, call Calidyne now.

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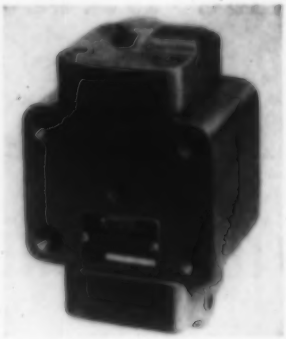
New Parts



a rated capacity of 8 gpm and is recommended for use in systems with operating pressures up to 2000 psi. It requires pilot pressure greater than 40 per cent of system pressure to open. Units are available with either 30, 75 or 150 psi cracking pressure. **Vickers Inc.**, 1400 Oakman Blvd., Detroit 32, Mich.

Circle No. 96, Page 221, for more data

High-Pressure Hose 97

⅜, ½ and ¾-in. sizes

Available in ⅜, ½ and ¾-in. sizes, No. 1508 high-pressure flexible hose withstands severe surge peaks in industrial hydraulic applications. It performs satisfactorily at 5000 psi in the ⅜-in. size and at pro-

portionate pressures in the larger sizes. Two larger sizes use standard Aeroquip detachable and reusable fittings, and a special socket is available for the smallest hose. **Aeroquip Corp.**, 303 S. East Ave., Jackson, Mich.

Circle No. 97, Page 221, for more data

Small Gearboxes 98

in ratios of 4:1 to 12,000:1

Small, compact gearboxes for use in servo mechanisms, computers, small actuators and electronic components are offered in gear ratios from 4:1 to 12,000:1. Units are designed for mounting directly to small electric motors, or they can be supplied with an input shaft. Series 145 gearboxes provide up to 150 oz-in. of torque, while series 167 provide 200 oz-in. Weight ranges from 2½ to 5 oz. Maximum

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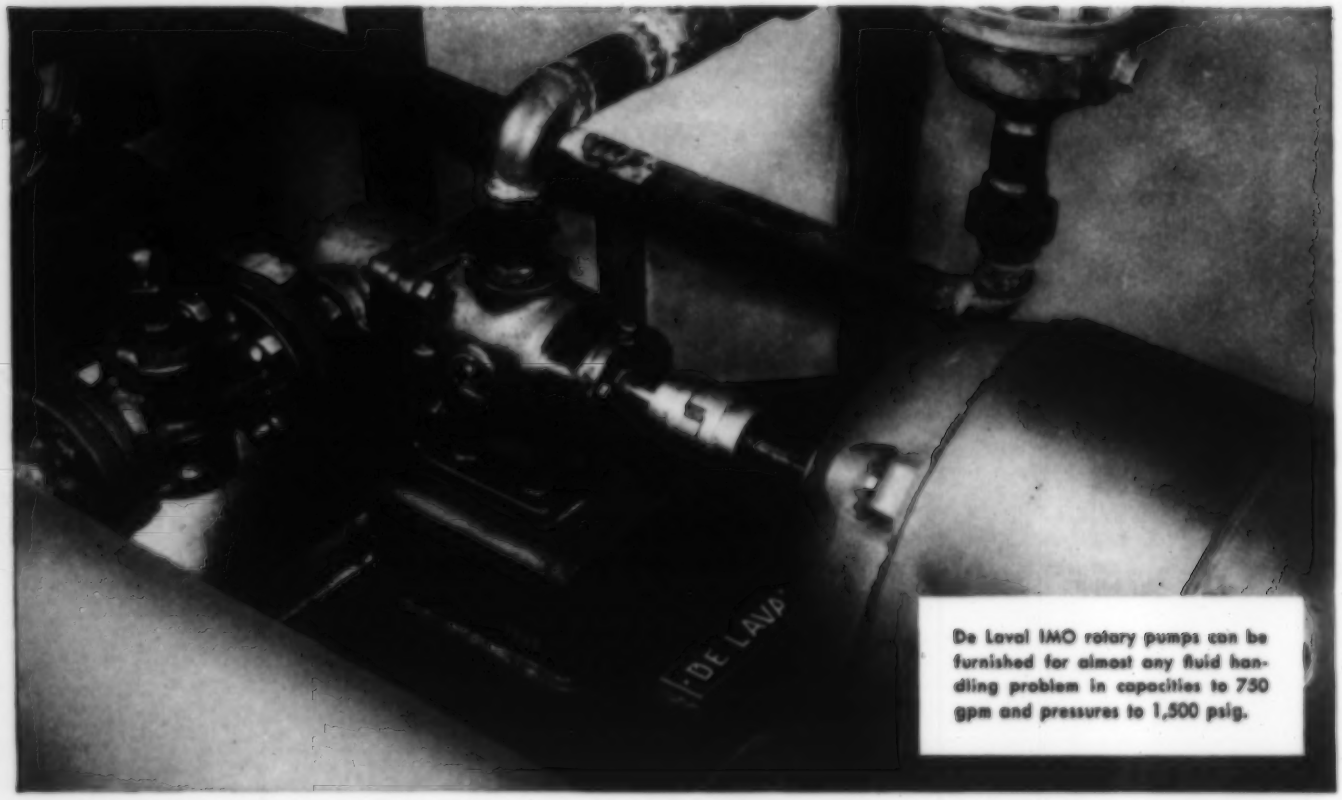


De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 1,500 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONCON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

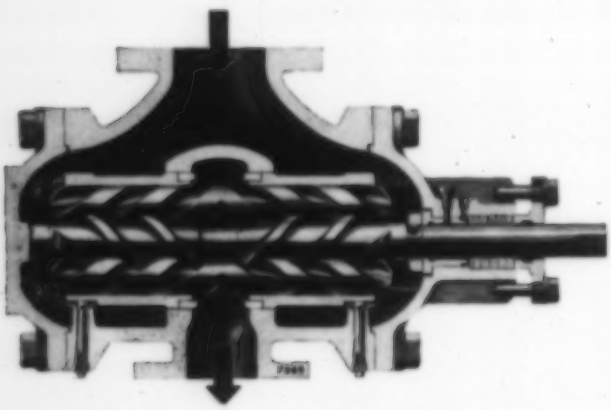
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



De Laval IMO Series A322A, a positive displacement, rotary screw type pump, can handle capacities to 750 gpm and pressures to 150 psig.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 858 Nottingham Way, Trenton 2, New Jersey. DL-301

output shaft backlash is 1 deg. Units are also available in standard U. S. Navy Bureau of Ordnance sizes 15 and 18. **Southwestern Industries,** 5880 Centinela Ave., Los Angeles 45, Calif.

Circle No. 98, Page 221, for more data

Electrical Foot Switch 99

top or circumference actuated

Positive contact is made with this electrical foot switch by pushing it on top or anywhere on its circumference with hand, elbow, knee or foot. Switch is suited for manufacturing process where worker

must have both hands free. It operates on 110 v, 10 amp and measures 3 3/16 in. in diameter and 1¼ in. high. Outer shell is molded Bakelite, and base is nonskid rubber. **Birtcher Corp.,** 4371 Valley Blvd., Los Angeles 32, Calif.

Circle No. 99, Page 221, for more data

Silicone Rubber Products 100

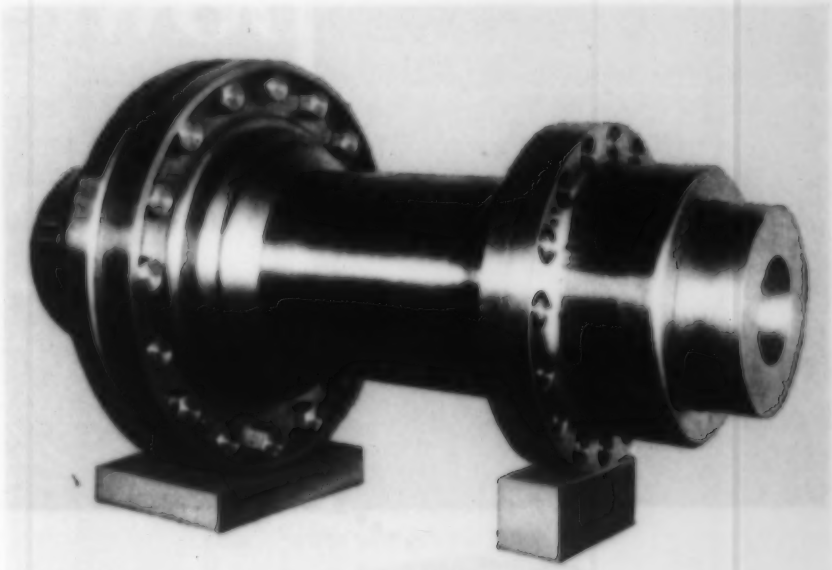
for compounding with various fillers

Two new Silastic intermediate silicone rubber products are a polymer designated 430 gum and a reinforced gum called 432 base. The gum has low set and low shrink characteristics. When properly cured, it provides tough, high strength silicone rubber parts that can be used at temperatures from −70 to 500 F. Parts also have low compression set. Fillers can be added to make the gum suitable for electrical insulating components which retain a high

(*Continued on Page* 254)

1800 lbs.

...is the weight of this SPECIAL forged steel insulated spacer WALDRON GEAR COUPLING



Despite its size and weight, it is in perfect dynamic balance.

The compressor or driven end is a size 8 gear half with the hub taper bored. The main motor, or drive end, is a size 6 gear half with the hub straight bored. The forged steel spacer is 24" long.

The coupling will connect a 14,000 H.P. synchronous motor to an axial compressor. 18,000 maximum H. P. will be transmitted at 3,600 R. P. M.

This special insulated coupling is only one of many special units which we design and make.

We invite your inquiries regarding couplings to successfully solve your particular problem. No obligation.

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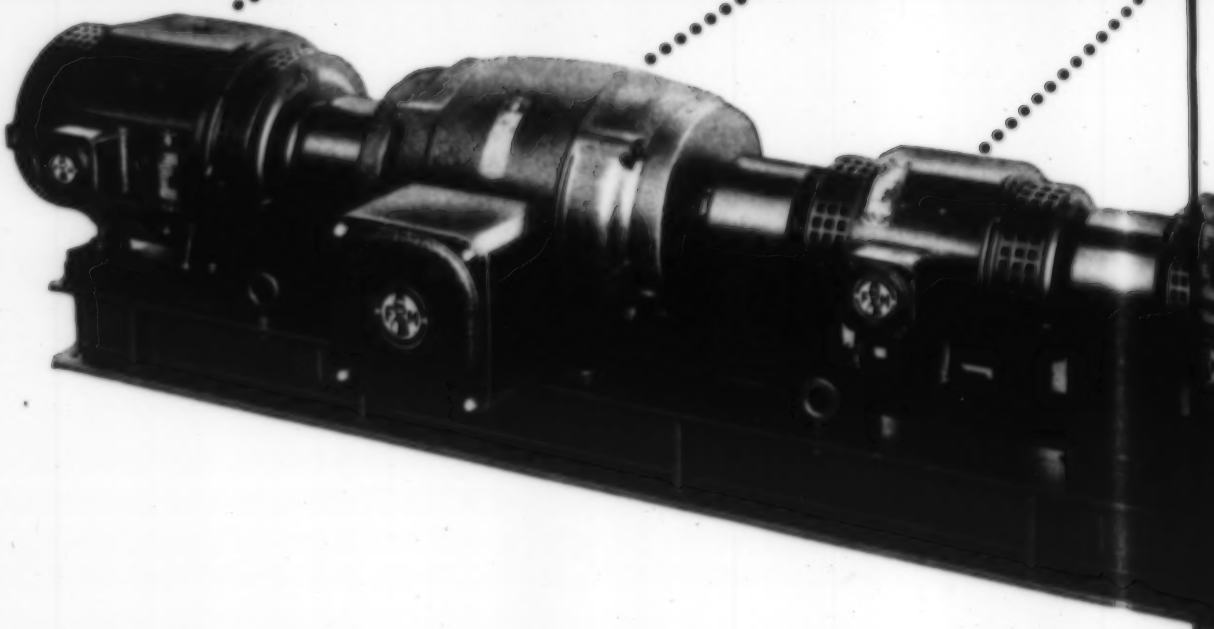

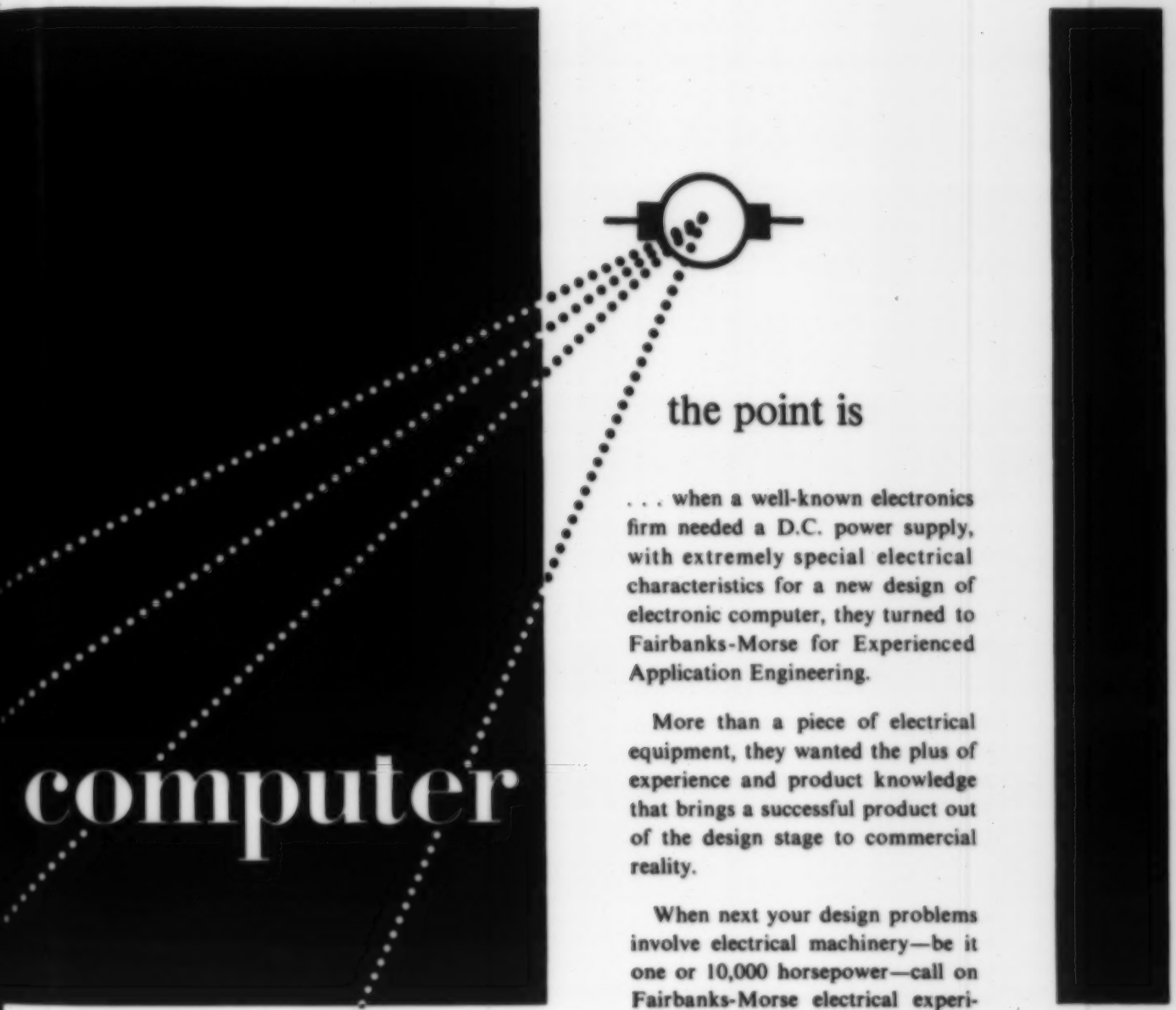

the point is

. . . when a well-known electronics firm needed a D.C. power supply, with extremely special electrical characteristics for a new design of electronic computer, they turned to Fairbanks-Morse for Experienced Application Engineering.

More than a piece of electrical equipment, they wanted the plus of experience and product knowledge that brings a successful product out of the design stage to commercial reality.

When next your design problems involve electrical machinery—be it one or 10,000 horsepower—call on Fairbanks-Morse electrical experience. Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

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In a financial sense Pratt & Whitney Aircraft is *big* — strong, well-financed, the world's foremost designer and builder of aircraft engines. Yet it is not an impersonal, sprawling, industrial giant. It is primarily a design and development organization not a mass producer.

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New Parts

(*Continued from Page 251*)

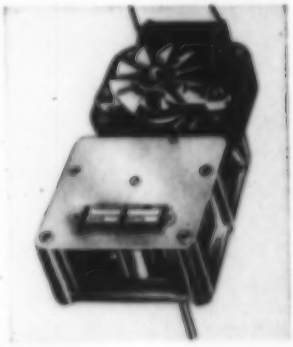
degree of dielectric properties at high temperatures and under high humidity or severe weather conditions. Silastic 432 base consists of 80 per cent silicone polymer and 20 per cent Silica filler. Inherent low shrink and low compression set characteristics eliminate the need for toxic additives. Compounds made from this base are usable for mechanical goods, gaskets and seals, extrusions and wire coating. **Dow Corning Corp.**, Midland, Mich.

Circle No. 100, Page 221, for more data

Geared Motor 101

with output speeds from 1 rpm

A two-pole, shaded-pole induction motor, equipped with fan for cool operation, powers this compact subfractional horsepower speed reducer or geared motor. Units are



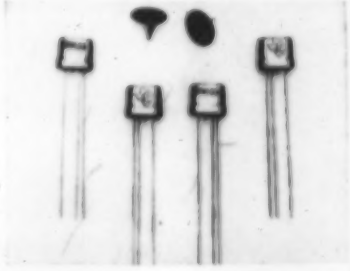
available in 1/500 to 1/75-hp ratings, with output speeds from 1 rpm and up. Basic induction motor is also available without the gear housing. **Loyd Scruggs Co.**, Festus, Mo.

Circle No. 101, Page 221, for more data

Switching Transistors 102

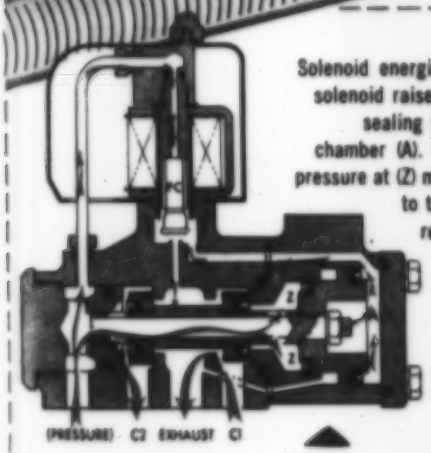
operate at high speed

Four types of germanium n-p-n transistors are designed for general purpose switching and com-



5 major advances in a 4 way SOLENOID VALVE

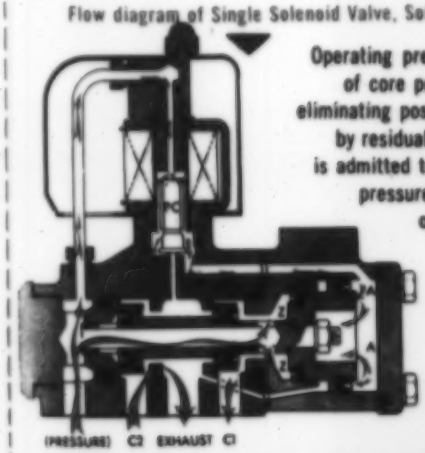
1. **Absolutely tight seating on air or liquids**
2. **Safe, positive operation**
3. **Single or dual Solenoids — for circuit design versatility**
4. **Mountable in any position; operates up to 850 cycles/minute**
5. **Simple design — easy maintenance**



Solenoid energized — energizing the solenoid raises the pilot core (PC) sealing the pressure inlet to chamber (A). (A) is exhausted and pressure at (Z) moves the valve piston to the right. Pressure on resilient inserts forces them against the metallic junction of disc and seat in an absolutely tight seal.

Flow diagram of Single Solenoid Valve, Solenoid Energized

Flow diagram of Single Solenoid Valve, Solenoid De-energized



Operating pressure applied to top of core pushes it off the seat, eliminating possible sticking caused by residual magnetism. Pressure is admitted to (A). While the same pressure exists on both sides of the piston, (A and Z) the area on the right is greater. The resultant force moves the piston to the left.

DUAL SOLENOID VALVE —added safety feature! Locks into position on power failure; coil must be energized for piston movement.

Designed to function perfectly at speeds far in excess of normal requirements, this new 4-way, poppet-type ASCO Valve makes possible a fresh approach to design engineering. It is especially applicable for punch presses, welding machines, machine tools, indexing operations, and air operated clutches and brakes.

1. ABSOLUTELY TIGHT SEATING is assured — with no grinding, lapping or close adjustments. ASCO overcomes the leakage factor that was inherent in the earlier slide valves with a completely new design principle. Valves have been operated for many millions of cycles with no leakage on air!
2. SAFE, POSITIVE OPERATION is provided by the unique pilot action, poppet-type construction and power operation in both directions; piston malfunctioning caused by residual magnetism or binding is eliminated. No return springs are used; fluid pressure alone activates the valve.
3. SINGLE OR DUAL SOLENOID VALVES in ⅜" to 1" pipe sizes.
4. MOUNTABLE IN ANY POSITION, this valve will operate up to 850 cycles/min. Available with standard, water-tight or explosion-proof solenoid enclosures; JIC construction is also provided.
5. SIMPLE IN DESIGN, it has only two moving assemblies — the pilot core and the valve piston. Operating parts are accessible—NO SPECIAL TOOLS ARE NEEDED.

There's one source that solves virtually any solenoid valve problem — ASCO. Have the ASCO Engineer call — or write today for complete data on the Single and Dual Solenoid Bulletin 8344.

ASCO

Solenoid Valves

How about Malleable ?

Toughness . . . Ductility . . . Impact Resistance in Easily Machined Castings

Malleable iron is a cast ferrous alloy heat treated to a remarkable combination of toughness, strength, ductility and machinability. It can be cast close to final form and, unlike most cast material, can be further formed by press or coining operations greatly reducing machining cost. Holes often can be punched eliminating expensive drilling operations.

Whether you are designing new products or reviewing current production it will pay you to consider malleable. Call a malleable foundry and have their engineers go over your parts with you. They can give you information and suggestions to help you design better products that can be made at lower cost.

Send for "Malleable Iron Facts" useful information on Malleable properties and uses.

Schedule a showing of the Malleable Founders' Society Technicolor sound film, "This Moving World". The story of Malleable Iron — how it is made, tested and used. Available on request to groups of production men, engineers, students or others.

Ask your malleable castings supplier or write to the Malleable Founders' Society, Union Commerce Building, Cleveland 14, Ohio

1800 Union Commerce Building Cleveland 14, Ohio

New Parts

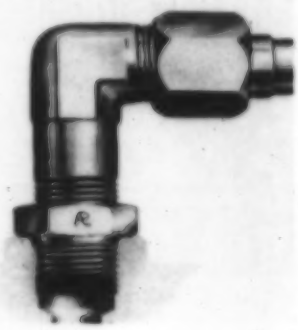
puter applications. They are made with closely held parameter tolerances and are hermetically sealed. High-speed switching is exemplified by one model which has rise time in a typical circuit of 0.15 - microsecond and cutoff time of 3.5 microseconds. Bearing RETMA designations of 2N124, 2N125, 2N126 and 2N127, the individual types have beta values of 12 to 24, 24 to 48, 48 to 100 and 100 to 200. **Texas Instruments Inc.**, 6000 Lemmon Ave., Dallas 9, Tex.

Circle No. 102, Page 221, for more data

Tube Fittings 103

have straight thread mounting

Line of tube fittings for internal straight thread boss mounting includes swivel nut elbows and tees for use with straight thread connectors. They are made in both the Triple-lok standard JIC 37-deg flare type and the Ferulok flareless



type. Fittings are steel and are sealed with O-rings. Elbows and tees have locknuts for adjustable positioning. The fittings are comparatively short, with a small hex. **Parker Appliance Co.**, Tube and Hose Fittings Div., 17325 Euclid Ave., Cleveland 12, O.

Circle No. 103, Page 221, for more data

Porcelain Enamel 104

on aluminum foil
in wide range of colors

Suitable for individual or continuous lamination to many kinds of backing materials, aluminum foil as thin as 0.0005-in. is available in matte and glossy colors. Typical backing materials are plywood; pressed wood; and fiber, asbestos and gypsum board. The 50-in. wide

now.....
VEEDER-ROOT
gives you

instant "push-button" resetting

Just press the easy-acting lever on this Quick-Reset Ratchet Counter . . . *and all 4 figures reset to zero as instantly as though you used a push-button.* This saves time and speeds work on short machine runs, inspection and many other jobs. Counter is compact . . . 2.69" long, 1.44" high, 1.29" wide. The 4 white-on-black figures are .166" high. You can order it (Series 1126) from stock right now . . . just like scores of other Veeder-Root Counters for manual, mechanical and electrical operation in every field from electronics to atomics.

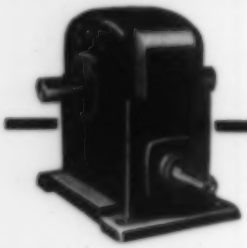
VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT
Greenville, S. C. • Chicago 6, Ill.
New York 19, N. Y. • Montreal 2, Canada
Offices and Agents in Principal Cities

EVERYONE CAN COUNT ON
VEEDER-ROOT
"THE NAME THAT COUNTS"

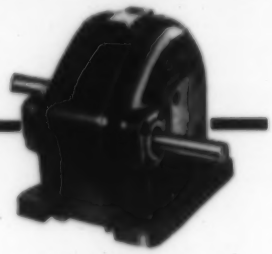
Modern Design

DPL SERIES

for Modern Performance



HS — Single reducers. 5 sizes. No. HS-0-1-2-3-4. Ratios, 5-1 to 100-1. Capacities, ¼ H.P. to 5 H.P. The input shaft is below, the output shaft above. Output shaft may extend to right, to left, or both right and left.



HH — The HH line of Helical Reducers is available in 3 sizes: Nos. HH-1-2-3. Ratios are from 3-1 to 12-1. Torque capacities 147 in. lbs. to 1450 in. lbs.

SPECIFY

OHIO

- Smooth Design
- Clean Construction
- Quality Throughout
- Conservatively Priced
- Greater H.P. Capacities
- Quick Delivery

HU — Single reducers. Same as HS series except input shaft is above and output shaft below. Includes 5 sizes, HU-O-1-2-3-4. Ratios, 5-1 to 100-1. Output shaft may extend to right, to left, or both right and left.

• *Protect your product and operation with Ohio Speed Reducers.*

BOX — An extremely sturdy and versatile reducer of the "baby" size, measuring 4 15/16" in length, 3 5/16" in width and 4 1/2" in height. Shaft extensions are 1 11/32". Ratios, 4-1 to 1600-1. Torque capacities 25 in. lbs. to 150 in. lbs. 4 variations of input and output shaft available.

ESTABLISHED 1915

OHIO GEARS

OHIO GEAR COMPANY

1338 E. 179th ST. CLEVELAND 10, OHIO

New Parts

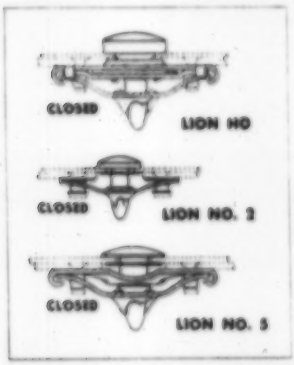
foil is available in 500-ft coils. **Keasby Corp.**, Keasby, N. J.

Circle No. 104, Page 221, for more data

Panel Fasteners 105

close with one-quarter turn

A clockwise quarter-turn locks these fasteners, designed to hold plates of metal, plastic or plywood pressure-tight. Fastening of maintenance and inspection panels on aircraft, trucks, busses, electronic equipment and air conditioning units is typical of many possible uses. Fasteners withstand shock, vibration and extreme stress. They



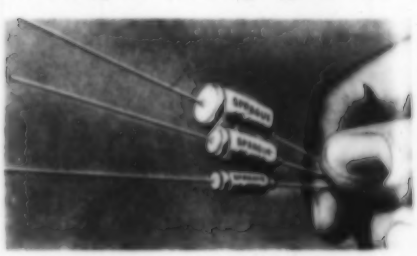
cannot be partially or incorrectly locked, nor over-torqued. Full-floating leaf spring assures quick access. The one-piece forge stud is grommeted tightly to the outer panel, and a spring assembly is spot welded or riveted to the inner sheet. The three standard types are shown. Oval, flush, knurled, ring, notched, wing or specified head styles are available. **South Chester Corp.**, Southco Div., 200 Industrial Highway, Lester, Pa.

Circle No. 105, Page 221, for more data

Miniature Capacitors 106

for transistor circuitry

These hermetically sealed aluminum electrolytic capacitors range in size from 3/16-in. diam by ½-in. to ⅜-in. diam by ¾-in. Low



magnesium

Extruded, Cast, Drawn, Welded and Machined

. . . it's all magnesium

Make it with magnesium if it must be *light in weight*. Make it with magnesium if you want *easier fabrication*, too!

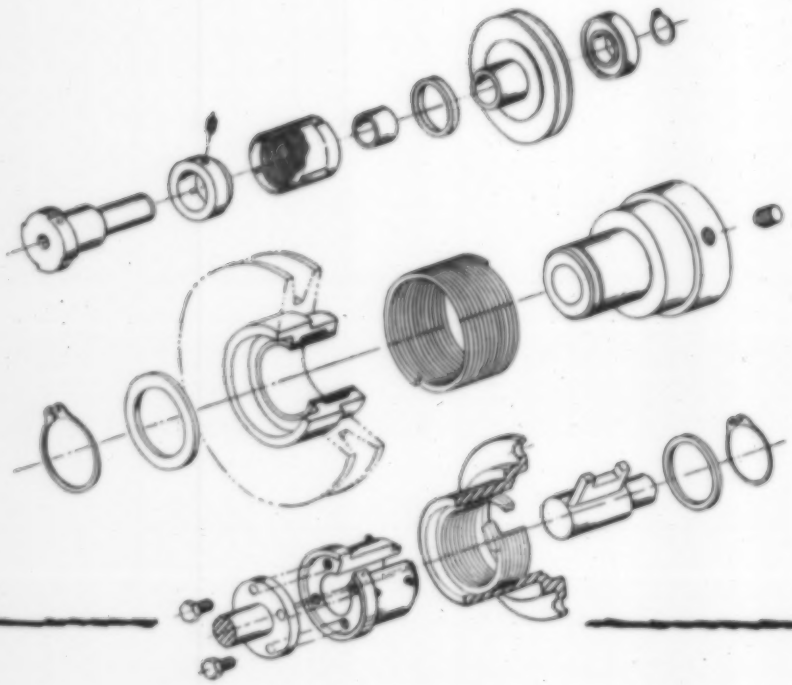
In this ballistics control housing the advantages of magnesium are being utilized. Extruded, cast and drawn parts are welded into a composite unit, then machined and painted. This is common practice—magnesium provides these same plus values for many manufacturers who consider it a *typical production metal*.

Start your product on its way to better design—and production—with magnesium. Complete engineering and fabrication facilities are available at Dow's Bay City Division as well as from other fabricators located throughout the country. THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 305C, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW

When you need a clutch...



check into the many advantages of Marquette SPRING CLUTCHES

OVER-RUNNING or FREE-WHEELING CLUTCHES • INDEXING CLUTCHES
BI-DIRECTIONAL NO-BACK BRAKES • REVERSING CLUTCHES
SINGLE REVOLUTION CLUTCHES • DELAYED ACTION CLUTCHES

LOW COST • COMPACT • TROUBLE-FREE

Marquette Spring Clutches have given dependable service for many years in a wide range of applications—from Aircraft to X-ray. They require very little space. They maintain their efficiency almost indefinitely. And they cost much less than other types of clutches.

Send today for your copy of illustrated manual that gives helpful data on Marquette Spring Clutches!

The Marquette
METAL PRODUCTS CO.
SUBSIDIARY OF CURTISS-WRIGHT CORPORATION

ALSO MANUFACTURERS OF: ROLLER BEARING TEXTILE SPINDLES
HYDRAULIC GOVERNORS • PRECISION PARTS AND ASSEMBLIES
AIRCRAFT WINDSHIELD WIPERS • FUEL OIL PUMPS & INJECTORS
ROTARY HIGH PRESSURE OIL FIELD PUMPING MACHINERY

A PRODUCT OF CW CURTISS-WRIGHT

THE MARQUETTE METAL PRODUCTS CO.
1141 Galewood Drive, Cleveland 10, Ohio

Please send manual describing the functions, applications and operations of the basic types of Spring Clutches.

COMPANY _____

NAME _____ TITLE _____

ADDRESS _____

New Parts

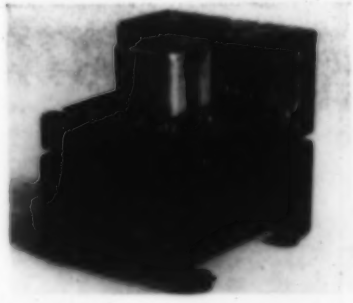
leakage current assures minimum drain and long battery life when the capacitors are used in filtering applications across a battery, as well as good circuit performance when they are used in coupling applications. Capacitors are available in ratings from 1 to 110 mfd and in standard working dc voltages of 1, 3, 6, 10, 12 and 15 v. Maximum operating temperature is 65 C. **Sprague Electric Co.**, 167 Marshall St., North Adams, Mass.

Circle No. 106, Page 221, for more data

Motor Speed Controls 107

maintain preset speed within 2 per cent

Compact dc motor speed controls are designed to deliver stepless control from absolute stop to above base speed. Motor speed remains constant within 2 per cent



after setting, despite line and load variations. Dynamic braking, reversing and other features are available. The speed sensing element is a sensitive, high-gain finger type regulator. A 1/15-hp control is illustrated. **Electric Regulator Corp.**, Pearl St., Norwalk, Conn.

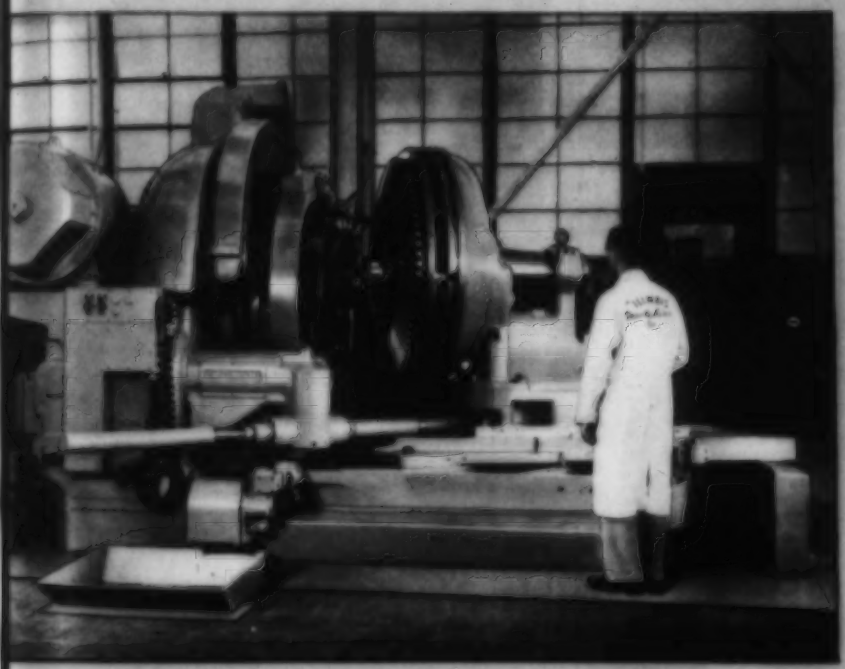
Circle No. 107, Page 221, for more data

Batch Counter 108

can be preset to any figure up to 99,999

Batch counter is designed to control the number of items in a batch to be counted or measured with control of quantity before or after an operation. The standard model can be preset at any figure within the range of five digits. At each impulse the preset figure is decreased by one until the counter reaches zero. The counter then performs the control function. As

BIG SPIRAL BEVEL ZEROL BEVEL HYPOID GEARS



PRECISE GENERATION OF BIG BEVEL GEARS

This new No. 170 Spiral Bevel and Hypoid Gear Generator is the nucleus of the most modern and productive unit of large bevel gear generating machinery in the world. It generates spiral bevel, zerol bevel, and hypoid gears to 72" diameter, 2.875" tooth depth (.75 D.P.), 10" face, and 10" hypoid pinion offset above or below centers. The localized gear tooth bearing, an established necessity for today's heavily loaded gear drives, is precisely controlled to your specifications.

POWER TESTING—This new No. 61 Angular Hypoid Testing machine is the most advanced of its kind. Large spur, helical, herringbone or bevel gears are operated under load at any shaft angle, giving exact inspection of tooth contact under operating conditions. It will efficiently test gears up to 90" diameter and hypoid offsets to 10" above or below centers.

SURFACE HARDENING—This new No. 2 Flame Surface Hardening machine is closely controlled electronically to produce precise, uniformly distortion-free results—it's the all important climax to our large gear production facilities. Spur, helical, bevel and hypoid gears to 120" diameter, .75 D.P., and 18" face are surface hardened in this machine.

Visit our modern plants—see the finest equipped plants in the world—designed to serve you.

Look for this mark ILG *... the symbol on finer gears*

ILLINOIS GEARS Reg. U.S. Pat. Off.

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

3 JOHN CRANE "Pressed-In" SEALS

for economy, quick installation and life-long performance in all types of service

TYPE 11-A

Synthetic Rubber Bellows • Small shafts to ¾ in.

Services: hot or cold water, oil, gasoline, kerosene and other liquids non-injurious to synthetic rubber.

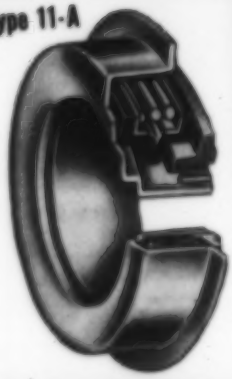
Pressures: up to 50 psi.

Temperatures: –65°F. to +220°F. Special construction to +300°F.

Construction Data: Packaged unit. Retainer does not contact shaft, permitting operation at a high rpm. One size can be used for several shaft sizes. Bellows encloses spring and metal parts to prevent contact with medium being sealed.

TYPE 6-A

Synthetic Rubber Bellows • Interchangeable with Type 11-A



Services: hot or cold water, oil, gasoline, soapy and other liquids non-injurious to synthetic rubber.

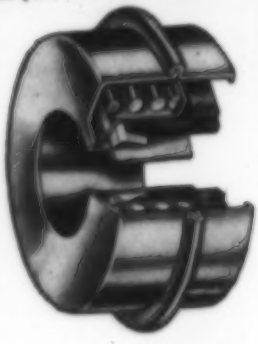
Pressures: up to 75 psi.

Temperatures: –65°F. to +220°F. Special construction to +300°F.

Construction Data: Similar to Type 11-A. Does not contact shaft, permitting operation at high rpm. One size can be used for several shaft sizes. Spring and metal parts available in stainless steel or bronze.

TYPE 9-A

Sealing Members Made of Teflon* • Engineered for the particular application



Services: all chemicals, solvents, oils, corrosives and gases, hot or cold.

Pressures: to 150 psi. Balanced construction to 750 psi.

Temperatures: –120°F. to +500°F.

Construction Data: Packaged unit. Furnished in metallurgical specification best suited to the application. Chemically-inert Teflon wedge ring closely fits inner sleeve of retainer and is machine-mated to carbon sealing washer.

Contact "John Crane" for the particular seal best suited to your application. Request bulletin giving full information on "John Crane's" complete line of mechanical seals.

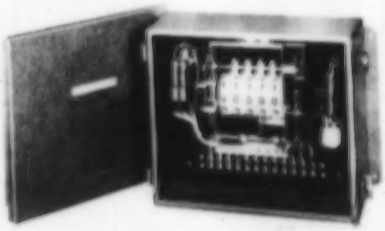
Crane Packing Co., 1825 Cuyler Ave., Chicago 13, Illinois.

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

*DuPont trademark

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PRIMACY

New Parts



further impulses are received the counter adds one for each until the original preset figure is again reached, then it performs the control function once more and starts the subtracting operation again. It continues to operate until the preset figure is changed. The counter is 5 in. deep, 10 in. high and 12 in. wide. Mounting can be made as required. **Spencer Mfg. Co.**, 3253 N. Cicero Ave., Chicago 41, Ill.

Circle No. 108, Page 221, for more data

Magnetic Disk Brake 109

for rerated NEMA frame sizes

Redesign of the H-1200 magnetic disk brake for rerated NEMA frame sizes has reduced the diameter by 2 in. and has also shortened the length. For use in the

range from 50 to 100 hp, the brakes are available in torque ratings of 230, 345, 460 and 575 lb-ft. They can be supplied for motor or floor mounting and for operation on either ac or dc. **Stearns Magnetic Inc.**, 635 S. 28th St., Milwaukee 46, Wis.

Circle No. 109, Page 221, for more data

Moisture Separators 110

for compressed air equipment

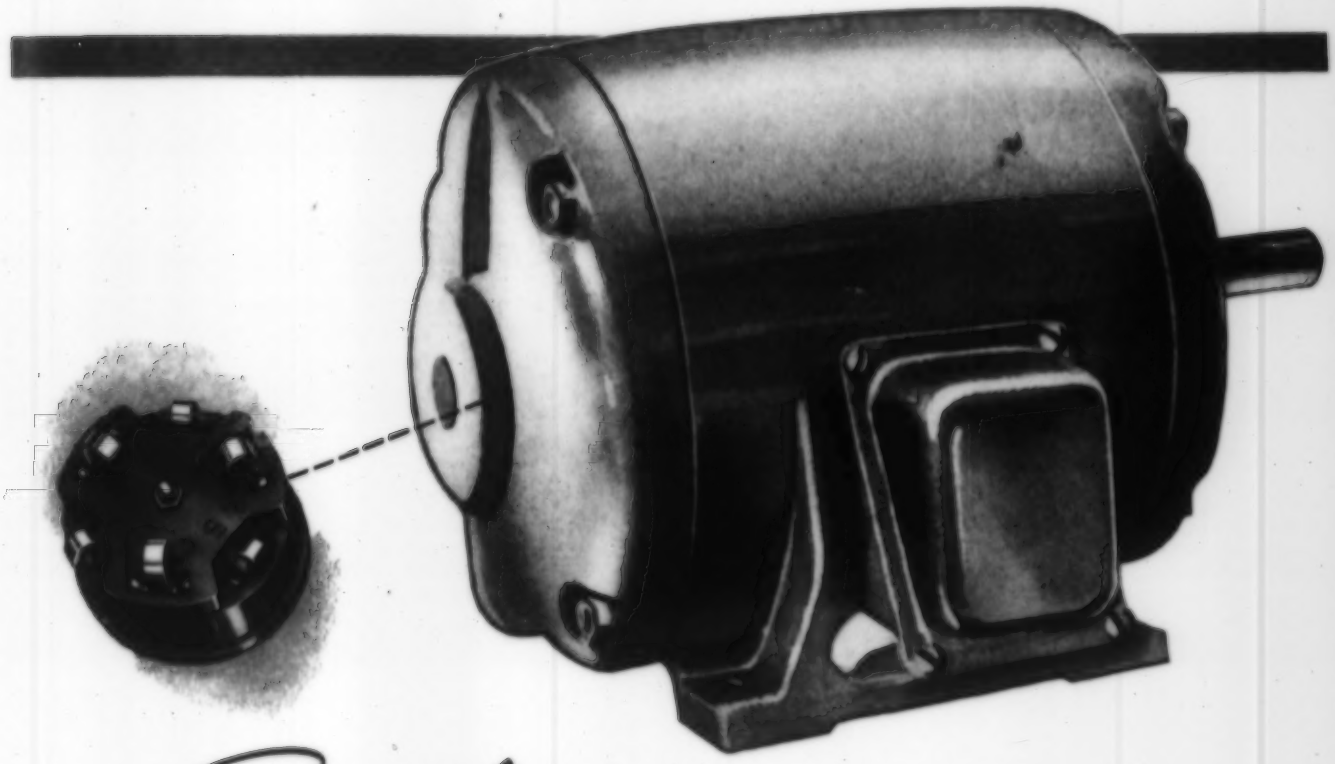
Compressed air equipment operating between 10 and 250 psi can be protected from free oil, water and nongaseous contaminants by series 125 moisture discharging separators. These piston operated units do not increase air requirements and will not flutter. Sepa

IT'S HERE!

3-PHASE

Inherent Motor Burnout Protection

That Allows Full Motor Capacity With Maximum Safety



Specify

3-Phase Motors with Built-in

KLIXON PROTECTORS

In the past, where 3-phase motors have had to rely on remote overload devices, many motor burnouts could be traced to the wrong size heater having been installed to avoid nuisance trips. The machine designer, simply by specifying motors with KLIXON Inherent Protectors, can now be assured that his motors will not burn out, yet will deliver maximum motor capacity.

KLIXON Inherent Motor Protectors provide positive protection against overheating from all running and stalled rotor conditions:

- **Extremely heavy overloads**
- **Single-phasing**
- **Stalling**
- **Failure to start**
- **Lack of ventilation**
- **Increase in ambient temperatures**
- **Plugging or reversing duty**

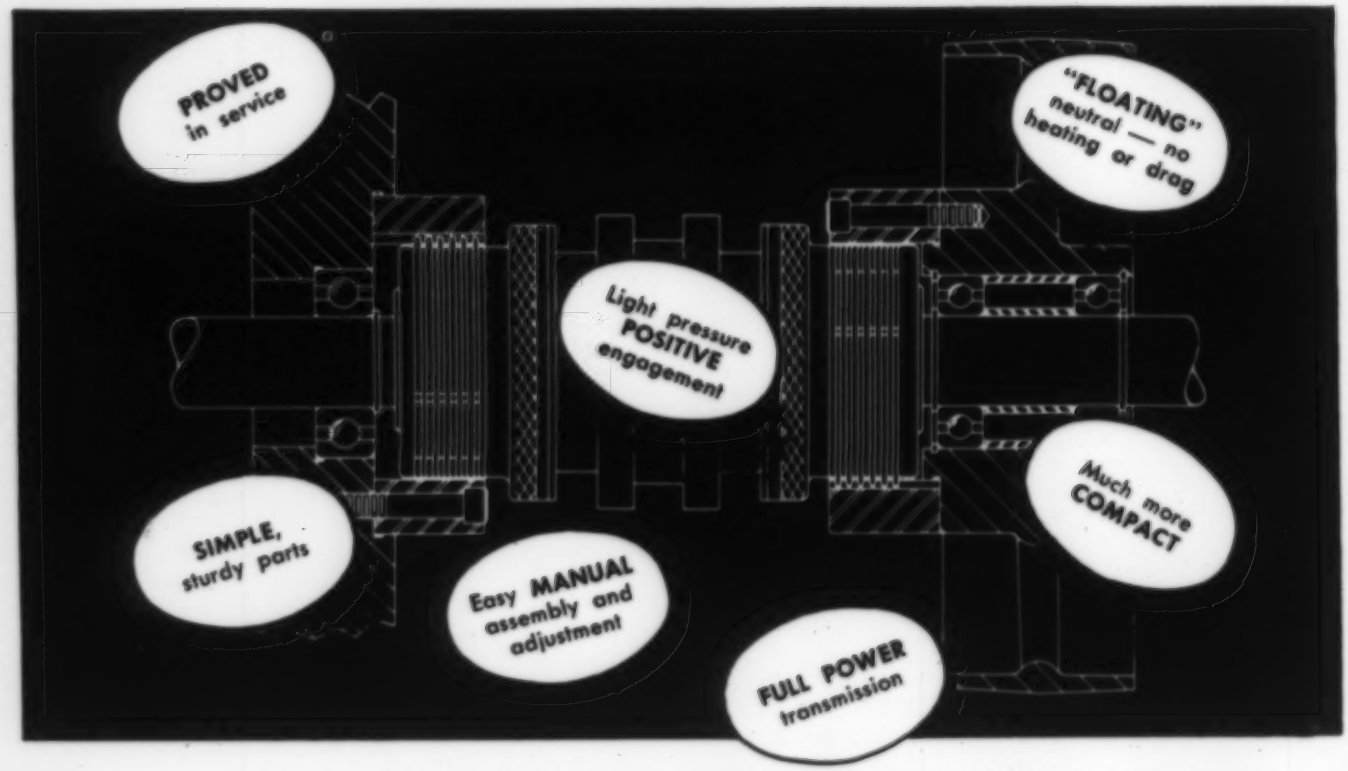
KLIXON 3-Phase Motor Protectors are available in four sizes — covering a range of horsepower ratings from fractional up through 7½ hp. (600V.), single or dual voltage. Write for Bulletin MOPR-1 which explains inherent motor protection.

KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3212 FOREST ST., ATTLEBORO, MASS., U. S. A.

ASSURE YOUR PRODUCT THE *PROVED* SUPERIORITY OF A

MAXITORQ *floating disc* CLUTCH


PROVED in service
"FLOATING" neutral — no heating or drag
Light pressure POSITIVE engagement
SIMPLE, sturdy parts
Easy MANUAL assembly and adjustment
FULL POWER transmission
Much more COMPACT

The line drawing shows typical application of a double Maxitorq Floating Disc Clutch, arranged for both drive and brake, with ring-type driving cups.

Such installations have a well-proved record of efficiency and freedom from maintenance. Drive and brake engagement and disengagement are smooth and positive . . . without drag or heating . . . because exclusive MAXITORQ design assures that discs ride free in neutral.

MAXITORQ Floating Disc Clutches are available in a wide range of sizes and types . . . single, double, overload release . . . to meet specific installation demands. Our engineering department also stands ready to help you solve special drive problems. Write or phone Dept. MD-12. The Carlyle Johnson Machine Company, Manchester, Conn.

Let's talk **MAXITORQ**

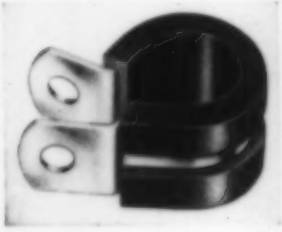
ration and discharge action is fully automatic. Four models for ¼ to ½-in. lines have 12 to 45 cfm efficiencies at 100 psi. Illustrated is the smallest model, which measures 2⅝ x 2⅝ in. **Wilkerson Corp.**, 3377 S. Platte River Dr., Englewood, Colo.

Circle No. 110, Page 221, for more data

Cushioned Clamps 111

resist heat and abrasion

Available in a wide range of sizes, No. 82626 silicone-impregnated, glass fiber cushioned clamps withstand temperatures ranging from −90 to 550 F. They also resist



abrasion and severe vibration. Installation and removal are accomplished quickly. A nonconductive layer of material is provided below the cushion for protection in the event the cushion material is charred at high temperatures. **General Metals Corp.**, Adel Precision Products Div., 1444 Washington Ave., Huntington 4, W. Va.

Circle No. 111, Page 221, for more data

Electromagnetic Pickup 112

converts mechanical motion to electrical energy

Model 3030 electromagnetic pickup is a small, highly sensitive impulse-generating transducer which converts mechanical motion into sufficient electrical energy to operate electronic devices. It is usable in the slow speed or very low

(*Continued on Page* 268)

This radar wave-guide throat section is cast of aluminum by the Antioch Process*. The specifications are rigid, but we meet them in production. Sample: center walls only .032" thick—inside finish meets electrical specifications as-cast.

The piece weighs 20 pounds and stands a foot and one-half high. Bean specializes in casting wave-guide, impellers and other parts of aluminum to demanding standards. Write for the Bean portfolio of difficult casting case histories. Or send a part print for recommendations.

Morris Bean & Company
Yellow Springs 2, Ohio

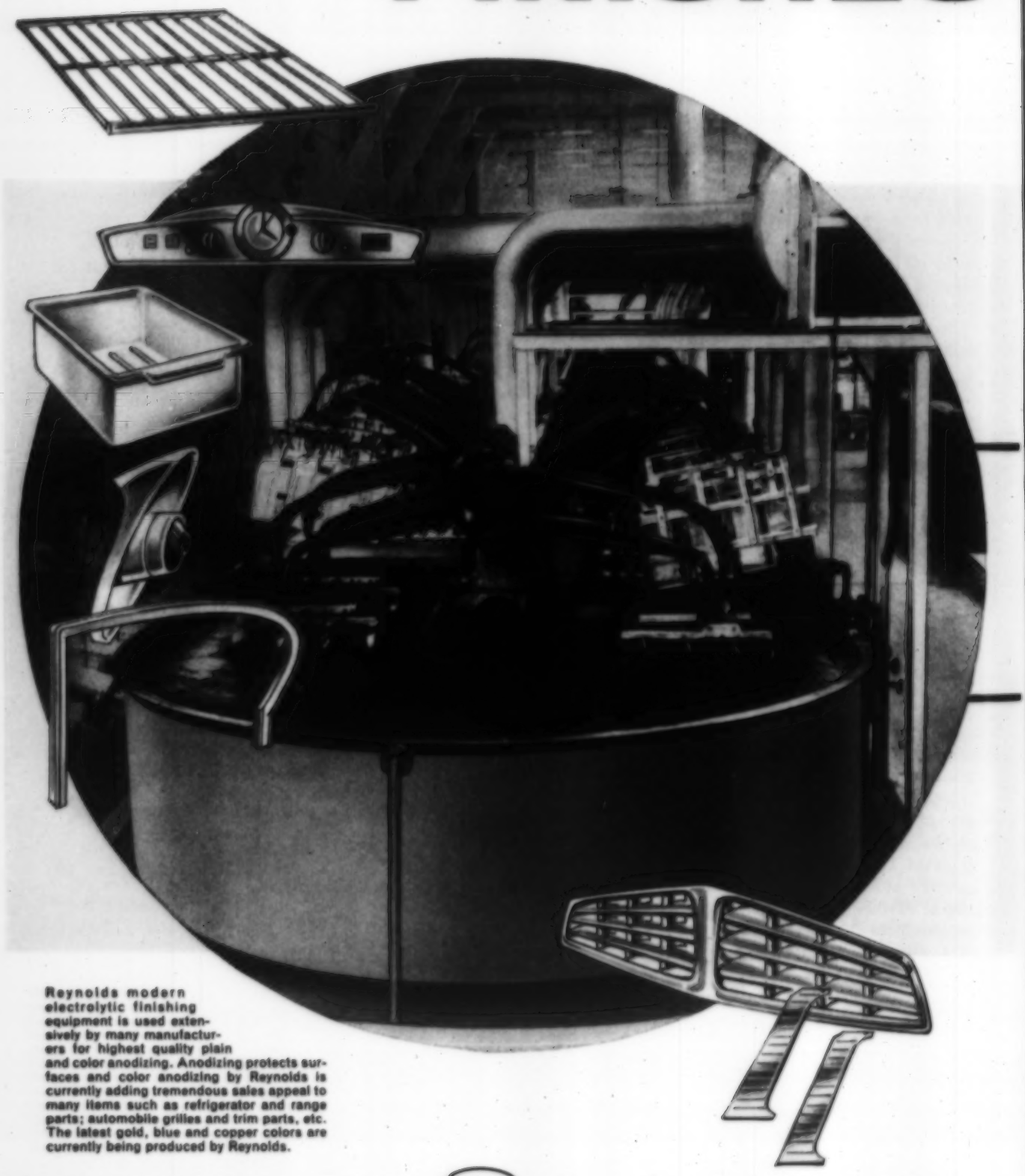
*Technical literature about the Antioch Process will be sent on request.

antioch process casting

BEAN

for finer "finished" aluminum products

FINISHES



Reynolds modern electrolytic finishing equipment is used extensively by many manufacturers for highest quality plain and color anodizing. Anodizing protects surfaces and color anodizing by Reynolds is currently adding tremendous sales appeal to many items such as refrigerator and range parts; automobile grilles and trim parts, etc. The latest gold, blue and copper colors are currently being produced by Reynolds.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING • BRAZING

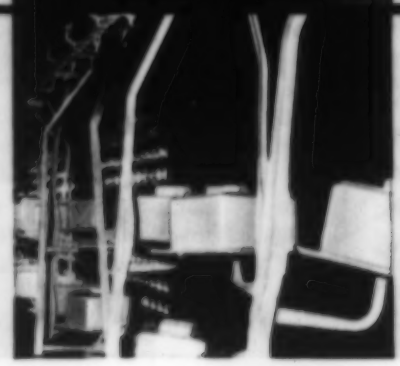
. . . greater design freedom, specify

from REYNOLDS

Mechanical • Chemical • Electrolytic • Paint Films

Buffing, here on deep well cookers, is one type of mechanical finish available from Reynolds. Scratch-brushing, satin finishing, highlighting, embossing and other finishes are also available.

Alodine system at Reynolds is adaptable to immersion, spray or brush type finishing. Etching, brightening and other chemical finish treatments are also available at Reynolds.



Reynolds can paint entire parts a solid color, mask and paint or do paint filling in combination with mechanical finishing to supply practically any desired texture or highlighting effect.

The aluminum products you are designing now can be finished to meet your requirements by Reynolds Aluminum Fabricating Service — and here's why:

Reynolds existing extensive finishing facilities are currently being augmented by today's latest automatic finishing equipment. This tremendous investment by Reynolds offers you finishing facilities unsurpassed anywhere. It assures you finer finishes on the aluminum products you design. Gives you new flexibility in your design thinking. And — these new expanded facilities are backed up by Reynolds years of technical experience with practically every finishing process and technique applicable to aluminum . . . and by Reynolds famous quality control from mine to finished product.

For the highest quality from start to "finish," let Reynolds fabricate and finish your aluminum parts.

For full details on the many types of mechanical, chemical, electrolytic and paint film finishes that Reynolds offers and on the many other services offered by Reynolds, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or write *Reynolds Aluminum Fabricating Service, 2061 So. Ninth St., Louisville 1, Ky.*

Write for your free copy of the 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

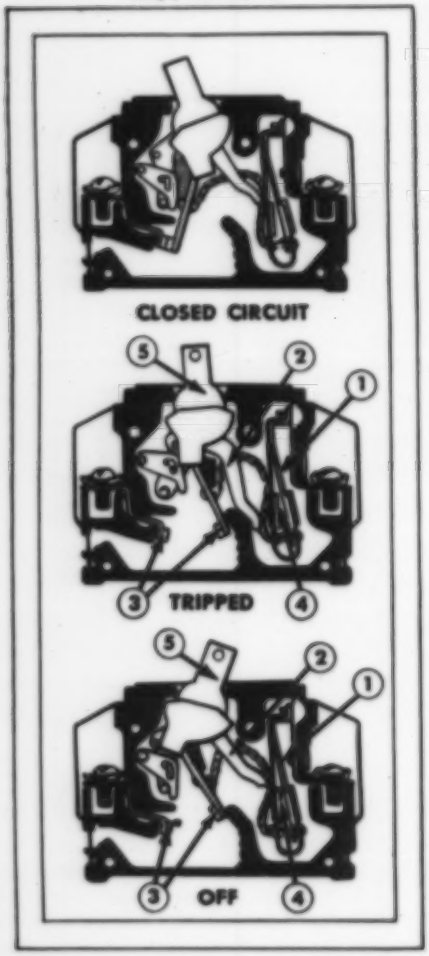
See Reynolds New Program "Frontier" Sundays on NBC-TV.

FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • FINISHING • IMPACT EXTRUDING

How CHACE THERMOSTATIC BIMETAL Actuates the Westinghouse AB CIRCUIT BREAKER

Product of Westinghouse Electric Corp., Beaver, Pa.



Westinghouse AB Circuit Breakers are made in a wide range of capacities and types to provide foolproof protection against electrical current faults in residential, commercial or industrial wiring systems. Westinghouse AB Circuit Breakers employ a thermal-magnetic action for *sure* response to gradual or sudden overloads and short circuit faults.

HOW IT WORKS

A Chace Thermostatic Bimetal element (1) responds to temporary overloads by deflecting in a direction away from the spring loaded latching arm (2) causing the contact rocker to break the circuit at contacts (3) in response to the same spring tension. Under conditions of sudden, high overload, the magnetic trip element (4) trips the latching arm in the same manner. A simple flip of the reset handle (5) again closes the circuit after the fault has been cleared from the line.

Chace Thermostatic Bimetal is available in 29 different types, in coil, strip, or in complete elements fabricated to your specifications. To aid the product designer of thermally responsive devices, we offer a free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal." *Write today for your copy.*

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

New Parts

(*Continued from Page 265*)

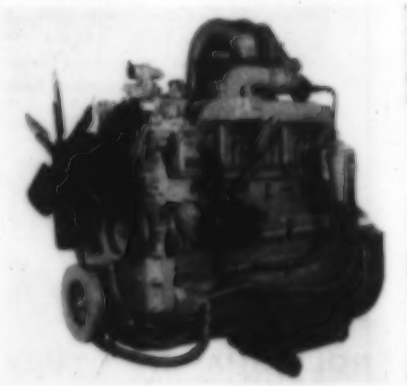
excitation range. The coil spool of the transducer is mounted on a soft iron pole piece which is silver brazed to an Alnico V magnet. This assembly is potted into the stainless steel shell with epoxy encapsulating resin. Impedance is 2800 ohms at 1000 cps; dc resistance is 1500 ohms ±10 per cent. Overall size of the transducer is 2 1/16 x ¾-in. diam. Weight is 2 oz. High-temperature model 3030-HTAN is designed for use at temperatures to 500 F. **Electro Products Laboratories**, 4505 N. Ravenswood Ave., Chicago 40, Ill.

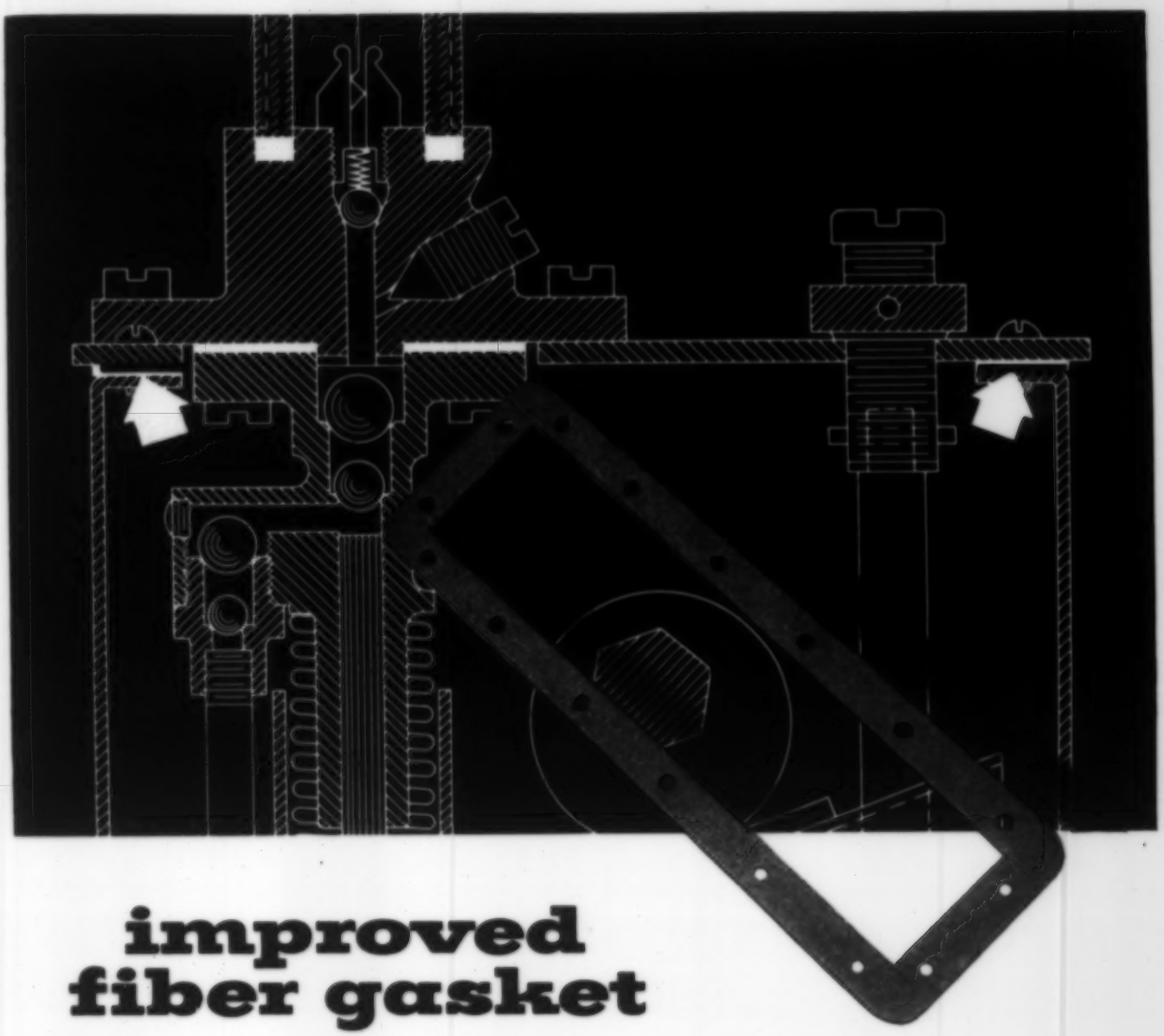
Circle No. 112, Page 221, for more data

Diesel Engines 113

incorporate turbochargers to provide high power

Rated at 250 and 262 hp at a maximum speed of 2100 rpm, NT-6 and NTO-6 diesel engines are turbochanged to provide optimum air-fuel mixture in the combustion chamber. Turbocharger utilizes exhaust heat and permits a large fuel charge to be burned completely, thus creating additional horsepower. Both engines are six cylinder, four-cycle type with bore and stroke of 5⅛ x 6 in. and piston displacement of 743 cu in. Compression ratio is 15.5 to 1. Turbochargers are available mounted on side or top. Design





improved fiber gasket

won't shrink, costs less, reduces fabricating time

A manufacturer was using four strips of gasket material which he butted together to seal the oil tanks and covers of force feed lubricators.

But the material was fragile, often had "lace" or pinholes, and was subject to shrinkage. Also, the strips had to be cut from sheet material . . . and this didn't produce pieces long enough to fit the largest tanks without splicing.

Problems were ended and costs lowered, however, by using Armstrong CN-705 Accopac® in ribbon form. This fiber gasket material is made by a beater saturation process that locks the fiber and cork in a latex binder. The lubricator manufacturer found it to be a uniformly strong and flexible material, free of porosity. Accopac did not shrink or leak.

Gasket fabrication was simplified, too. An operator simply cut the Accopac ribbon to length, cemented it into place, and punched the bolt holes.

Perhaps Accopac in sheets, rolls, ribbon, or die-cut parts can solve your gasket problem, too. Write today for samples for your own evaluation.

FREE 24-PAGE GASKET MANUAL— Look for "Armstrong Gasket Materials" in Sweet's product design file . . . or write for your own copy to Armstrong Cork Company, Industrial Division, 7012 Dean Street, Lancaster, Pennsylvania. **And be sure to specify Armstrong Gasket Materials when you order from your gasket cutter.**

Armstrong Accopac

. . . used wherever performance counts

START HERE

if you Want

Top Performance in

HOSE

ACME

Hose Products for applications involving

High Pressures
High Strength
Flexibility
Durability
Misalignment
Expansion
Contraction
and
Resistance to
Vibration
Shock
High
Temperature
Abrasion
Wear
Corrosion
Oil & Solvents

Every length of ACME'S varied line of RUBBER HOSE is specially engineered to meet the requirements of the application for which it is recommended. It is made by hose specialists in a plant devoted solely to hose manufacture for 53 years. What are your needs? Chances are we have it readily available in stock. If not, we'll make it for you.

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Acme

HOSE SPECIALISTS

ACME RUBBER MANUFACTURING CO.

1433 EAST STATE STREET TRENTON, N. J.

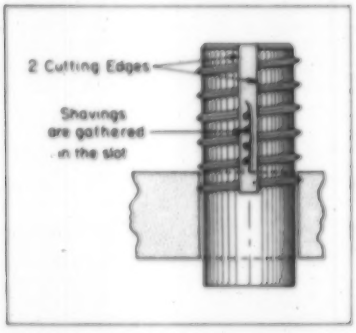
also includes fully counterbalanced drop-forged alloy-steel crankshaft, induction hardened bearing journals, viscous type vibration damper on front end of crankshaft and PT fuel system. This system permits operation on all commercial diesel fuel weights, although No. 2 diesel or furnace oil is recommended. **Cummins Engine Co.**, Columbus, Ind.

Circle No. 113, Page 221, for more data

Self-Tapping Setscrew 114

available in small sizes

Self-tapping setscrews in sizes as small as No. 2 x 3/32-in. are also self-aligning and self-locking. The cutting thread extends around the top or the slotted section only and offers two cutting edges, enabling



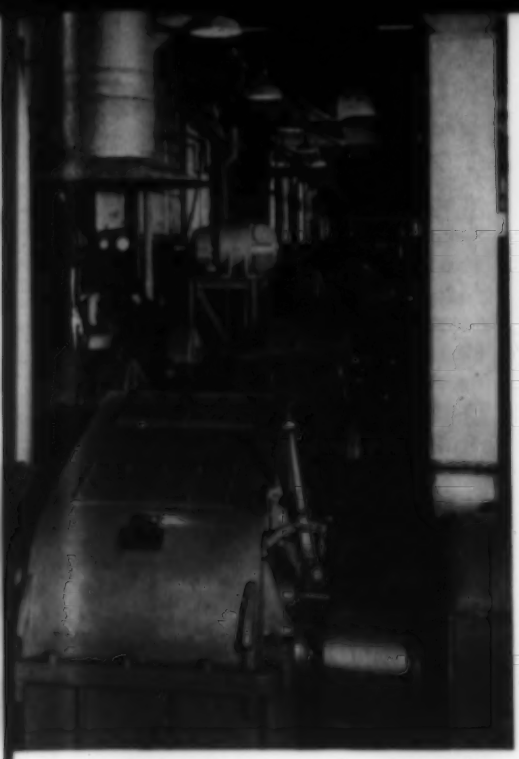
the screw to cut on both sides of the hole. Shavings are gathered in the slot. The screw can be supplied with any type setscrew point and can be used in metal or plastic. **Set Screw & Mfg. Co.**, 28 Main St., Bartlett, Ill.

Circle No. 114, Page 221, for more data

Connectors 115

are leakproof at high temperature and pressure

Vac-Tite model HS 2 (AN 3102) receptacles and HS 6 (AN 3106) plugs incorporate glass-to-metal construction for leakproof performance under conditions of extreme heat and pressure. These



RIGHT ANGLE PUMP DRIVES designed and manufactured by Western Gear shown here installed in the San Diego municipal water treatment plant. Western Gear manufactures a complete line of drives for high horsepower or high speed right angle application.

OUT OF THE CATALOG OR OFF THE DRAWING BOARD

WESTERN GEAR CAN FILL YOUR MACHINERY REQUIREMENTS!

FORMERLY a prominent mill lost time changing gears for processing heavy grades of Kraft board because of additional drag and increased load which overtaxed the motor. Western Gear solved the problem by installing a two-speed drive with optional ratios of 6.94:1 and 14.04:1 with 400 HP input in either ratio. Gear changes now are made by merely shifting a lever. Man hours were saved and motor overload was prevented.

WESTERN GEAR diesel-engine-driven speed increasers, among the largest ever constructed for U.S. pipeline service, are exclusively used on Mid-Valley's 1,000-mile pipeline. Daily pumping capacity of this huge pipeline has been increased recently by the addition of two new 1800 HP units.

Whatever the application, call on Western Gear engineers for assistance. Their recommendations are based on experience accumulated since 1888 in the design, testing and manufacture of virtually any type of mechanical power transmission equipment. This extensive background in special machinery design and construction ranges from fractional horsepower motors to mammoth marine cable laying devices, from pulp mill machinery to tiny guided missile components and from printing presses to peach pitters.

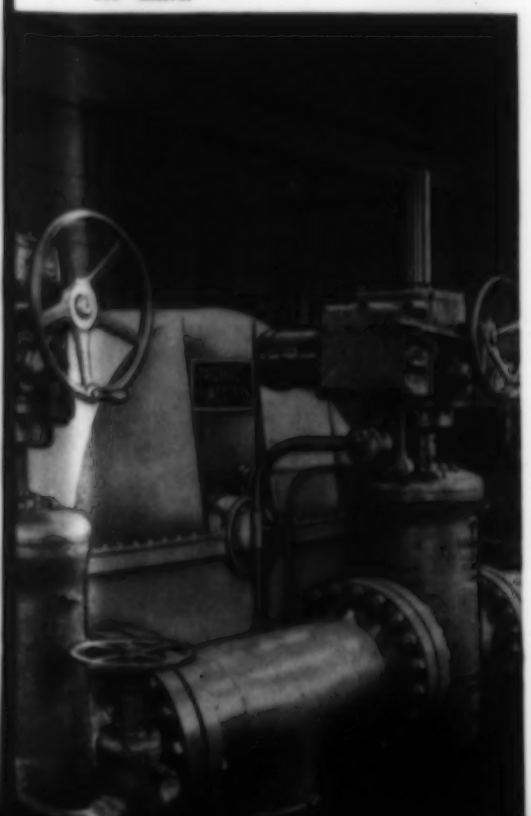
Western Gear skill has contributed to virtually every industry. The experience and knowledge obtained is your assurance of reliability and outstanding performance. For help on your problem, write General Offices, Western Gear Corporation, P.O. Box 182, Lynwood, California.

"The difference is reliability" • Since 1888

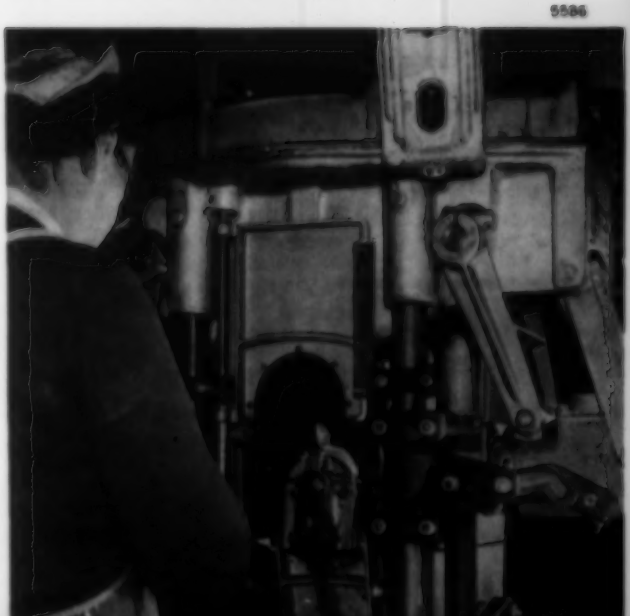
WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

WG

9586



PEACH PITTER which halves and pits cling peaches mechanically, constructed by Western Gear for the Filper Corporation to be used by the Filice & Perrelli Canning Company, a leader in the California fruit canning industry. The Filper process is said to improve both the quality and the yield while it also reduces hand labor.



PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

PACING INDUSTRY WITH RESEARCH

Chief Sandusky

FERROUS AND NON-FERROUS CENTRIFUGALLY CAST SLEEVES, ROLLS, LINERS, TUBES, RETORTS, CHUTES, RINGS, BUSHINGS, BEARINGS, ETC.

Our continuing development program is a major factor in meeting your ever increasing demands for ferrous and non-ferrous centrifugal castings. And research is a vital phase in keeping ahead of your requirements.

Precise metallurgical control is maintained throughout the entire manufacturing process to produce strong, uniform, close-grained castings which are extremely resistant to heat, corrosion, and abrasion. Excellent machining facilities for turning, boring, and drilling are also available.

You can rely on Chief Sandusky as a versatile integrated centrifugal specialist where castings are produced to your specific requirements with modern, up-to-date equipment.

C. M. Lovsted & Co., Seattle, Wash. • Tynes Bros., Birmingham, Ala. • Cordes Bros., San Francisco and Wilmington, Calif.

Chief SANDUSKY CENTRIFUGAL CASTINGS

FERROUS AND NON-FERROUS

SANDUSKY FOUNDRY AND MACHINE CO., Sandusky, Ohio

New Parts

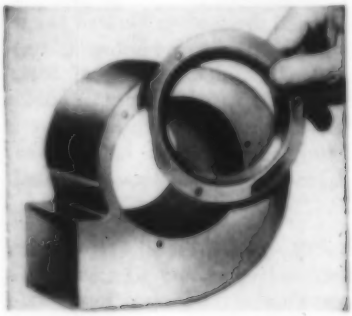
connectors are usable where the vacuum tightness and arc resistance of glass are necessary during high-temperature operation. They resist shock and vibration, corrosion, moisture and pressure. Connectors meet requirements of MIL-C-5015 specifications. **Hermetic Seal Products Co.**, 33 S. Sixth St., Newark 7, N. J.

Circle No. 115, Page 221, for more data

Blower Housing 116

for 3¾-in. wheel

Small blower housing, designated model 350, is designed for a 3¾-in. wheel and is available in all practical widths. Standard assemblies are provided with open side plates to facilitate mounting of dual inlet flanges or single flange



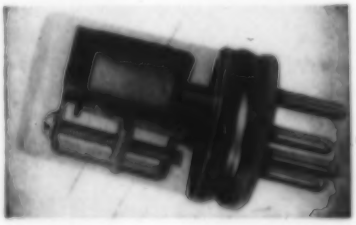
and cover plate, for quick adaptation to clockwise or counterclockwise wheel rotation. Housings are available with integral inlet flange or blank cover plate on either side to meet special requirements. **Detroit Stamping Co.**, 350 Midland Ave., Detroit 3, Mich.

Circle No. 116, Page 221, for more data

Frequency Relay 117

has range of 40 to 170 cps

Series TR frequency relay uses a 400-ohm coil as standard in the frequency range from 40 to 170 cps. Other frequency ranges are available. A maximum of ten standard relays can be installed in a control panel and each oper-



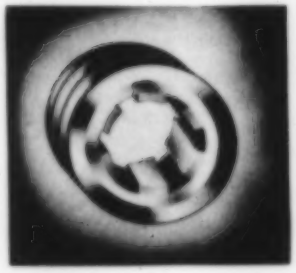
ated by a signal to which it has been tuned. In such an installation each relay will operate an auxiliary relay for closing or opening any circuit. **Potter & Brumfield,** Princeton, Ind.

Circle No. 117, Page 221, for more data

Socket Screw 118

has splines broached full length of socket

These socket setscrews are available in sizes from No. 4 wire to 1 in. diam. The socket is broached all the way through in either hex



or multiple splines and is symmetrical to permit wrenching the screw from either end. Holding power is equal to that of conventional socket setscrews. This fastener can be used either as a setscrew or locking ring. **Bristol Co., Socket Screw Div., Waterbury 20, Conn.**

Circle No. 118, Page 221, for more data

Encapsulated Transformers 119

for use with electronic equipment

Three new types of encapsulated transformers are designed for use in a range from Class H temperatures, in military applications re-

quiring MIL-T-27A grades 2 and 5 performance, to industrial and commercial applications requiring protection against grease, oil and corrosive atmospheres. Required degree of encapsulation can be specified. The various combina-

(*Continued on Page* 278)

PANELOC announces a new rotary latch

Saves Cost • Saves Time
Saves Space • Saves Weight

This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

PANELOC...America's most versatile line of aircraft fasteners . . . Rotary Latches, Styles 1, 2, and 3 Panel Fasteners, High Performance Fasteners, Snap Fasteners.

PANELOC—A product of Scovill

Scovill Manufacturing Company, Aircraft Fastener Div.
50 Mill Street, Waterbury 20, Connecticut
Please send me fastener catalogs checked:
( ) Rotary Latch ( ) Style 3 (MIL-F-5591A)
( ) Styles 1 & 2 (MIL-F-5591A) ( ) High Performance (NAS-547)
( ) Snap Fasteners (AN 227)
Send to:
Name _____ Title _____
Company _____
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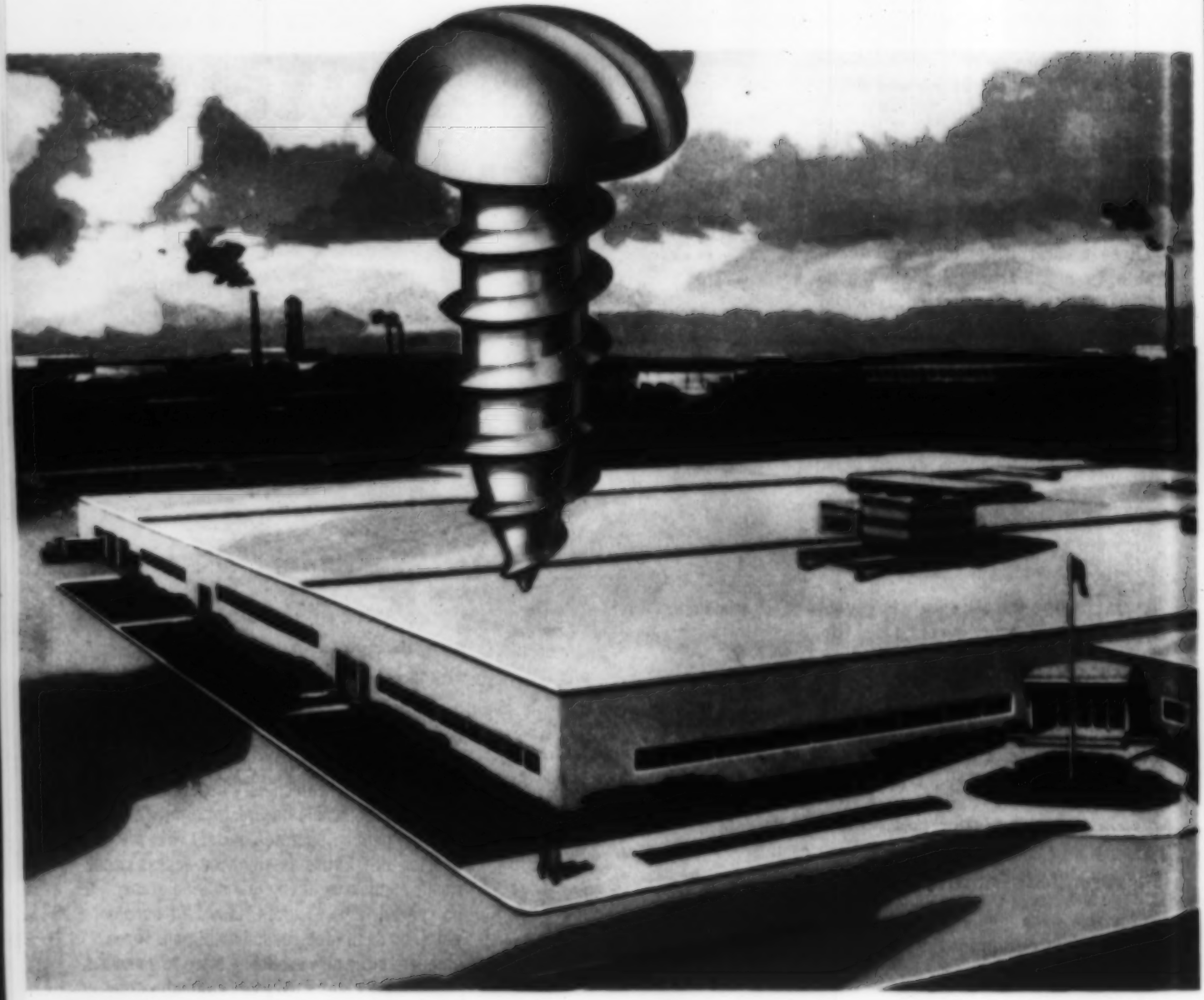
the new PARKER



IN CLIFTON, N. J. About 10 miles from New York City.

267,000 SQUARE FEET of floor space, with 225,000 sq. ft. for manufacturing: the remainder for offices, shipping, etc.

PRODUCTION-FLOW DESIGN Single-floor layout that permits progressive flow of products through processing operations.

MECHANIZED MATERIALS-HANDLING Special conveyor systems and other modern equipment provide advanced degree of automation, and speed production.

AUTOMATIC HEAT TREATING equipment, of P-K design, is typical of new production facilities for highest efficiency.

ADVANCED QUALITY CONTROL Newest inspec-

SELF-TAPPING SCREWS • SOCKET SCREWS • SCREWNAILS • MASONRY NAILS

-KALON® plant . . .

Production facilities matched with an unequalled experience . . . to offer you more assembly savings

Starting with a revolutionary idea, the *original* Sheet Metal Screw, Parker-Kalon has become the leading manufacturer of Self-tapping Screws and other fasteners essential to low-cost assembly of thousands of the nations best-known products.

Industry's reliance on Parker-Kalon has brought about this growth, and the new Parker-Kalon plant, in a real sense, was built to your specifications.

In this great new plant, P-K Fasteners will be produced in larger volume to meet steadily increasing demand. Advanced engineering facilities will also contribute to P-K progress in research and development.

Parker-Kalon's unequalled "know-how" is now matched with the finest facilities for all operations. Now, more than ever, you can be sure . . . "If it's P-K . . . it's OK!"

tion and testing equipment guards P-K quality standards.

PACKING AND SHIPPING area is fully equipped for rapid handling of large stocks and shipment of orders.

AIR-CONDITIONED LABORATORY provides all modern requirements for research, fastener development, and performance tests.

PARKER-KALON DIVISION

General American Transportation Corporation,
Clifton, New Jersey

Sold through leading Industrial Distributors

STAPS* • WING NUTS • THUMB SCREWS

*Registered Trade-mark

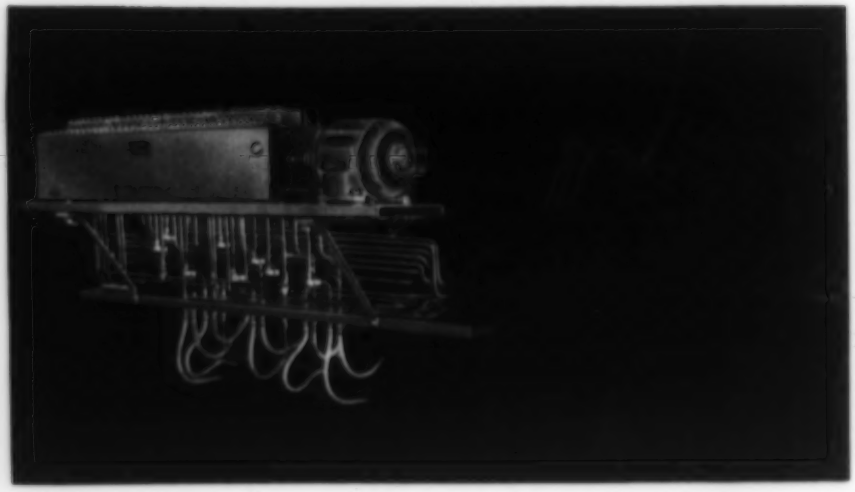
HOW BEST TO LUBRICATE

MANZEL *has the Answer!*

Pressure Application

Exact Amounts

Accurately Timed



★ Manzel has the answer to simple or complex questions of dependable, care-free, automatic lubrication — the answer to putting exactly the right amount of lubricant at the right places and right times — the answer to lubrication against discharge pressures as high as 30,000 P.S.I.G. There is a Manzel Force Feed Lubricator to meet your specifications. And Manzel engineers are specialists at adapting them to your special needs. To answer any lubrication problem, write Manzel.

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Professionally qualified engineering representatives throughout the country.

DIVISION OF

HOUDAILLE-HERSHEY CORP.

276 BABCOCK ST., BUFFALO 10, N. Y.

New Parts

(*Continued from Page 275*)

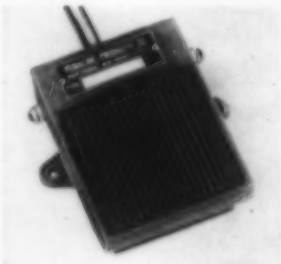
tions of encapsulations used include durable elastomer formulation and a Class A modified epoxy resin. **General Electric Co.**, Specialty Transformer Dept., Schenectady 5, N. Y.

Circle No. 119, Page 221, for more data

Foot Switch 120

heavy-duty type
has floor mounts

Designed for normal and heavy-duty switching of industrial machinery, model FS 15AM foot switch has a cast aluminum housing which will withstand severe usage. The actuating treadle operates with light pressure, and a



rubber foot tread prevents foot slippage. The switch can be mounted on the floor or to a machine, or is available without mounts. Contact rating can be 1, 6 or 15 amp. Switch is available with or without cord and plug. **Vemaline Products Co.**, P. O. Box 222, Hawthorne, N. J.

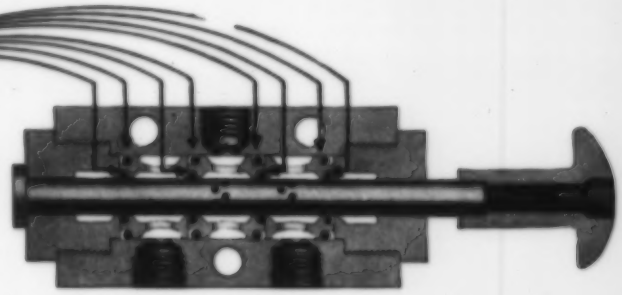
Circle No. 120, Page 221, for more data

Motor Load Indicator 121

shows percentage of load
or horsepower

Easily read scales of the MEK-2127 motor load indicator are calibrated in either percentage of load or horsepower and have large color bands to permit quick reading. Damping reduces needle waver from mechanical vibration or mi-

8 Precision "O" Rings



keep this Control Valve **under control!**

"Quick-As-Wink" CONTROL VALVE

"Quick-As-Wink" Control Valves by C. B. Hunt & Son, Inc., Salem, Ohio, feature simplicity of design, rugged construction and ease of operation. *Precision* "O" Rings make these great features possible. *Precision* "O" Rings are specified for their extra quality which insures a longer life of trouble-free service. Have a sealing problem? Get it under control quickly with *Precision* "O" Rings—tough, compression molded, rigidly inspected—finest "O" Rings made!

FREE—Write for your personal copy of our Handbook on "O" Rings.

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CORPORATION
"O" Ring and Dyna-seal Specialists

Box 431 Oakridge Drive, Dayton 7, Ohio Canadian Plant at: Ste. Thérèse de Blainville, Québec

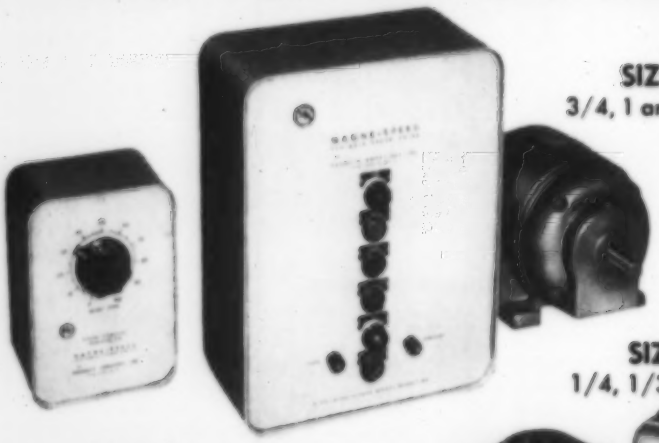
AFFILIATE OF GENERAL CERAMICS CORPORATION

Magnetic Amplifiers · INC

—announces its new

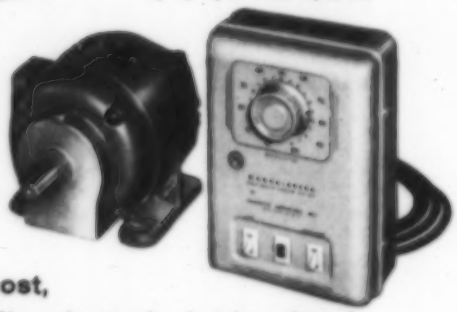
VARIABLE SPEED DRIVE

MAGNE-SPEED*



SIZE II —
3/4, 1 and 1-1/2 HP

SIZE I —
1/4, 1/3 and 1/2 HP



Stepless, instant starting, compact, 50:1 speed range, good regulation without tachometer, long life, virtually maintenance free service, low cost, fast response, reversibility, dynamic brake, local or remote control. Write for Bulletin S580-5-55.

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Application engineering and conversion of tool machines and production processes to automatic control.

Magnetic Amplifiers • Inc
Tel. CYpress 2-6610 • 632 TINTON AVE., NEW YORK 55, N. Y.

New Parts

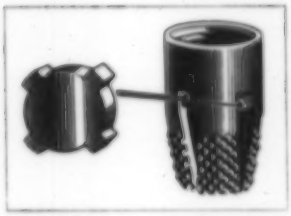
nor erratic load changes. The conversion unit can be mounted near the motor starter, and light control wires can be connected to the indicator. Dual-voltage units are adjustable for operation on either 220 or 440-v systems. Special scales can be supplied for any type motor or load. **Machinery Electrification Inc.**, Northboro, Mass.

Circle No. 121, Page 221, for more data

Thread Insert 122

can be installed in premolded plastic parts

Designed to be placed by hand or machine-fed into molded or drilled holes of plastic cabinets or parts after they are molded, Dodge expansion inserts have torque and



pull strength equivalent to that of molded-in thread inserts. The self-contained unit consists of a knurled brass shield and a locked-in spreader. Insert has a full thread to within 1/32-in. of its depth. As the spreader is driven downward, it expands the insert without contact with the threads. Insert is also usable in die castings and in all soft metal assemblies. **Phelps Mfg. Co.**, Colonial Green Bldg., Westport, Conn.

Circle No. 122, Page 221, for more data

Transformer 123

dc unit utilizes transistors

Small, lightweight transistorized dc transformer is completely static, with no bearings or brushes. It handles an input of 24 to 30 v dc and produces any dc output. Operating principle involves the conversion of dc to a square-wave ac signal which is stepped up or down and then rectified to give dc output. Regulation can be supplied within ±0.5-per cent. Output is available in 10 microseconds. Temperature range is from −80 and lower to 85 C. Shock and vibration characteristics are good, and

Here is the "INSIDE INFORMATION" on FALK ALL-STEEL Shaft Mounted Drives

Take a careful look inside the Falk all-steel Shaft Mounted Drive, and you will know why this newest member of the famous Falk family is ideal for applications where direct mounting on the driven shaft is desirable. It is the only drive in its field with all these superior "In-built" factors:—

1 **All-steel Frame,** with more than double the rigidity of iron, supports all rotating elements.

2 **Precision Helical Gears,** designed and machined by Falk, rated to AGMA standards.

3 **Pressed Steel Housings,** whose sole function is to keep oil in, dirt out; easily removed for gear inspection without dismounting unit.

4 **Through Hollow Shaft** with counter bore provides for easiest installation or removal from driven machine shaft extensions.

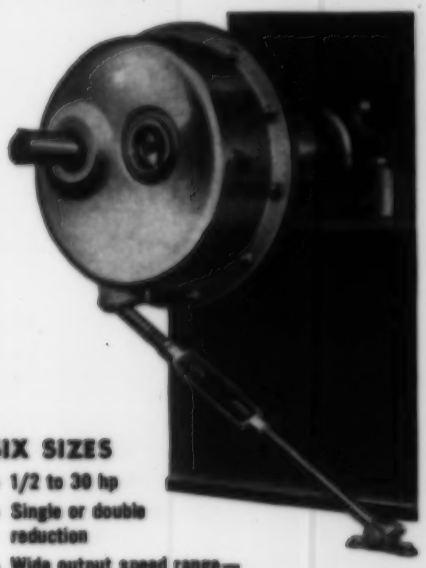
5 **Backstop** can be furnished with the unit or added later for positive prevention of reverse rotation.

6 **Positive Lubrication,** continuous direct dip of revolving elements at all speeds.

7 **Tie Rod** and turnbuckle serve as anchor and facilitate V-belt or chain adjustment.

Write to Department 247 for engineering bulletin, including selection and dimension details.

EFFICIENT SPEED REDUCTION IN LIMITED SPACE

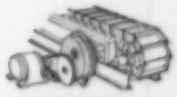


SIX SIZES

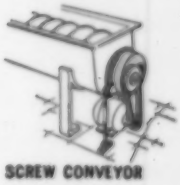
- 1/2 to 30 hp
- Single or double reduction
- Wide output speed range—420 to 10 rpm

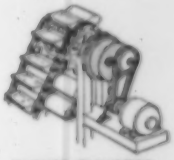
Expressly designed for topflight performance on installations requiring considerable speed reduction in limited space, the all-steel FALK Shaft Mounted Drive has quickly won acceptance throughout industry. This sturdy, compact, versatile reducing unit is an ingenious variation of the highly successful FALK Motoreducer design, pacemaker in its field for more than 20 years. Here, the time-proved design is adapted for mounting directly on the shaft to be driven, using V-belt connection to motor. Investigate now!

A FEW TYPICAL APPLICATIONS

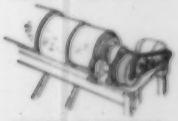

APRON FEEDER

LINE SHAFTING


SCREW CONVEYOR


BUCKET ELEVATOR

BELT CONVEYOR


GRAVEL CLASSIFIER

THE FALK CORPORATION, Milwaukee 8, Wisconsin

MANUFACTURERS OF

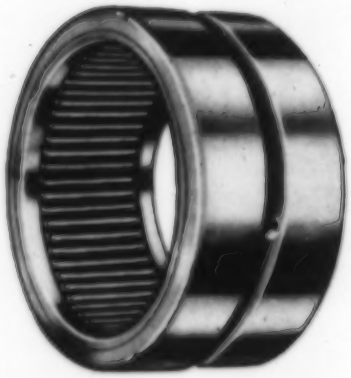
- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

...a good name in industry

ORANGE ROLLER BUSHINGS

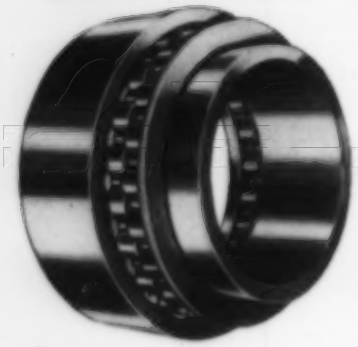
Maximum load capacity in small space

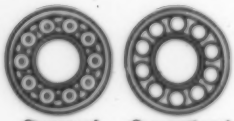


Install these space-saving full-type needle bearings to provide friction-free, long-life operation of rotating or oscillating parts. Electronically-gauged rollers permit closer internal running clearances, minimizing possibility of misaligned rollers. Quiet, even-running. Stock sizes ½" to 8" shaft diameters.

For heavy loads—severe service

ORANGE "STAGGERED" ROLLER BEARINGS

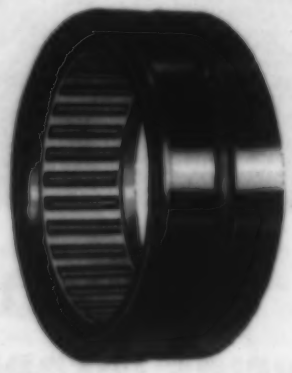




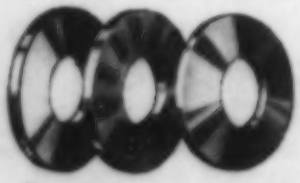
End views show how staggered roller arrangement distributes load over many short rollers, compared with conventional bearings. Often permits use of smaller bearings—always assures longer service life. Also prevents skewing tendencies of long rollers, provides more even running. All standard, fully interchangeable sizes.

ORANGE *Cage Type* NEEDLE BEARINGS

Prevent Roller Skewing

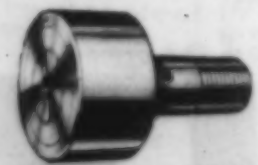


Anti-friction cage keeps rollers permanently aligned and true-running in any position—vertical, tilted, horizontal. Successful on overhung mountings and relatively high-speed installations. Less affected by misaligned mountings or uneven loading. Extremely smooth, quiet running. Sizes ½" to 8" shaft diameters.



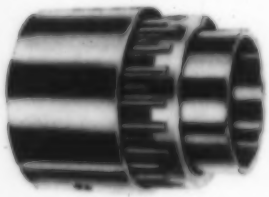
ORANGE THRUST ROLLER BEARINGS

Designed to provide maximum roller support for the load, with minimum wear. Available in designs and sizes to meet varying requirements.



ORANGE CAM FOLLOWERS

Compactly designed for high anti-friction protection under heavy load and intermittent shock. Available with standard or heavy studs, according to application.



ORANGE JOURNAL ROLLER BEARINGS

Provide high load capacity where radial space is limited, such as shafts close together or adjacent to shoulders. Available complete or component parts. Sizes ¼" to 5" shaft diameters.

ORANGE ROLLER BEARING CO., Inc.
556 Main St.
Orange, New Jersey

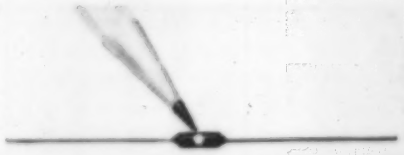
the transformer is unaffected by altitude. It is rectangular in shape and occupies 10 cu in. of space. **Nader Mfg. Co.**, 2661 S. Myrtle Ave., Monrovia, Calif.

Circle No. 123, Page 221, for more data

Precision Resistors 124

small units cover extensive resistance range

These highly stable, subminiature wire-wound resistors are supplied in either inductive or noninductive windings in sizes from ¼ to ¾-in. long. Resistance values vary from



0.10-ohm to 0.50 megohm. Standard tolerances of ± 1, 0.5, 0.25 and 0.10-per cent are offered. All resistors have temperature-coefficient of resistance of 20 ppm per deg C. **Precision Resistor Co. Inc.**, 107 U.S. Highway No. 22, Hillside 5, N. J.

Circle No. 124, Page 221, for more data

Protective Coating 125

penetrates surface of aluminum

Cold chemical finisher developed for aluminum, Alumblack has low surface tension and can be applied by dipping or spraying or with a cloth or brush. It leaves a dull gloss finish which can be rubbed to a high gloss. The coating penetrates the metal surface, causing no measurable tolerance deviation. **Birchwood Chemical Co.**, 4500 W. 44th St., Minneapolis, Minn.

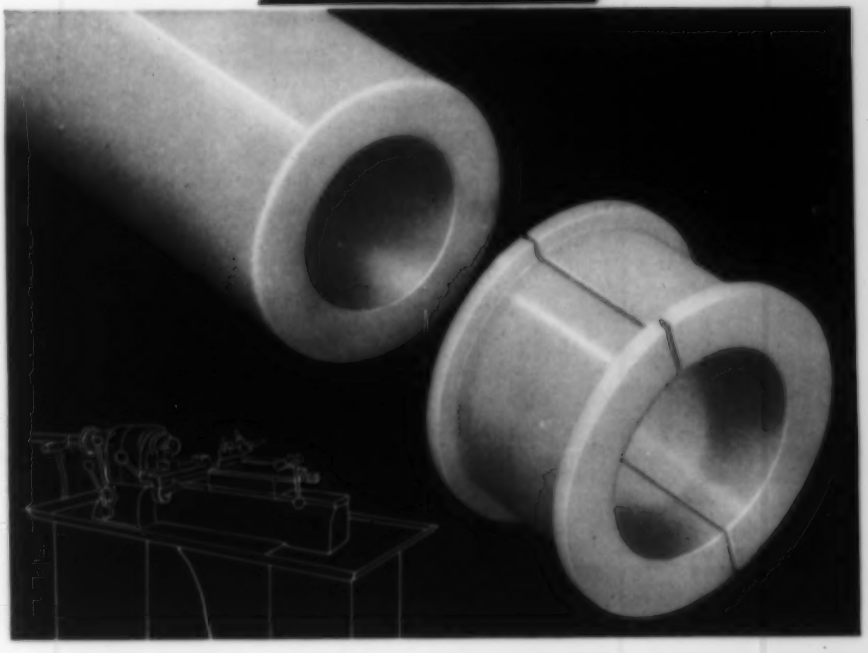
Circle No. 125, Page 221, for more data

Automatic Lubricator 126

holds accuracy of precision machinery

Constant-pressure rotary pump in this automatic lubricator maintains a continuous oil film of constant thickness on critical bearing surfaces. A pressure of 20 psi is maintained throughout the distribution system and at the lubrication points. Oil reservoir has

POLYPENCO® NYLON SHAPES



New Way To Cut Costs On Parts of Premium Quality Nylon

• More and more designers are learning today that the simplified solution to their needs for nylon bearings, bushings, gears, rollers and similar parts is to specify economical fabrication from high quality POLYPENCO Tubular Bar. Here's how it works:

MANY PARTS MACHINED FROM POLYPENCO NYLON TUBULAR BAR

One of the most widely used of the POLYPENCO shapes is the tubular bar which is supplied in sizes 2" through 10" to 12" O.D., with wall thicknesses of ½" through 1¼" depending on the O.D. Parts such as sleeve bearings, sealing rings, large bushings and rollers are frequently cut from standard sizes of POLYPENCO Tubular Bar and machined on ordinary metalworking tools.

USE YOUR OWN METALWORKING EQUIPMENT

No special equipment is required and operators need no special training to turn, mill, thread, tap, etc. in rapid, low-cost machining. Production is under your direct control and you can change design with complete flexibility.

HIGH QUALITY—STEADIER PRODUCTION

POLYPENCO Tubular Bar as well as other POLYPENCO Nylon Shapes are produced under the most rigid controls to assure a product with uniform density and dimensional stability. Controlled hardness and toughness plus absence of porosity and stress spots mean continuous production with fewer rejects.

Write for latest technical bulletins on POLYPENCO Nylon Tubular Bar and other shapes.

THE POLYMER CORPORATION of Penna. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine W., Montreal, P. Q.

POLYPENCO nylon, Teflon* and other non-metallics

*DU PONT TRADEMARK

Model MOD OIL-ACTUATED Multiple Plate Clutch (inset) is one of 6 Twin Disc Machine Tool Clutches incorporated in this power driven 8' Rotary Table with 50-ton capacity—manufactured by one of the world's largest machine tool makers, Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.

Why 6 Twin Disc Clutches are *standard* on new Giddings and Lewis Rotary Table

For *more constant* torque transmittal . . . *longer* wear life . . . *adequate* capacity in a small package . . . *elimination* of adjustment . . . and remote control at *minimum cost*—Giddings & Lewis uses *six* Twin Disc OIL-ACTUATED Multiple Plate Clutches as standard equipment for their new power driven 8' rotary table with 50-ton capacity. Included are: (1) Model MOD-806 and (2) Model MOS-806's on feed drive, with (3) MOS-806's on main transmission.

The Models MOS (single) and MOD (duplex OIL-ACTUATED Multiple Plate Clutches are Twin Disc's answer for a high energy, high inertia, high horsepower clutch especially adaptable to applications creating high temperatures and operating under heavy, abusive loads.

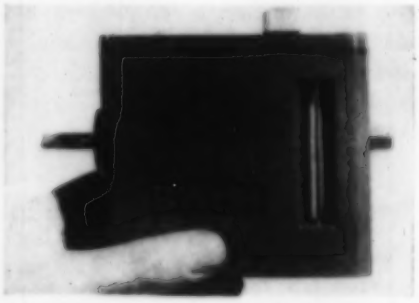
Both models are readily adaptable to remote or push button control without mechanical linkage. Since the floating or pressure plate forms the ram of the cylinder, ram travel increases automatically as plate stack wears. This eliminates adjustments to compensate for plate wear and constant torque transmitting ability is thus provided during entire life of clutch plates.

Find out how these OIL-ACTUATED Multiple Plate Clutches can be applied to your machines—write today to Twin Disc Clutch Company, Racine, Wis.

TWIN DISC

TWIN DISC

New Parts



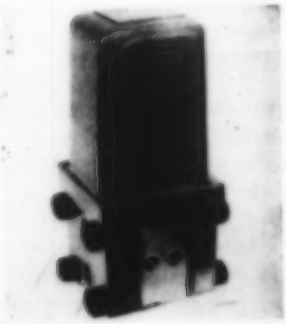
capacity of 1 pt. Driven by the machine or by a direct-connected 1/20-hp motor, the lubricator has a feed rate ranging from 0 to 27 cc of oil per minute, depending on rotation speed of the shaft, number of lubrication points and the fit of the bearings. **Bijur Lubricating Corp.**, 151 W. Passaic St., Rochelle Park, N. J.

Circle No. 126, Page 221, for more data

Flow Transmitter 127

for transmission of differential pressure

No working parts of the Figure 1575 force-balance transmitter contact the process fluid. Fluid pressures are exerted on smooth outside surfaces of two diaphragms which transmit pressure differential through a sealed-in oil chamber between them. Meter body and transmitter are separate assemblies. Adjustable damping built into the meter minimizes pulsation and vibration effects before they reach the transmitting half of the instrument. The transmitter is also stable to pipe strain, static pressure, temperature, position and random flow signal noise. Range of the transmitter is continuously adjustable from 0 to 20 to 0 to 200 in. of water and has an output of 3 to 15 psi. Pressure rating is 1500 psi, and temperature rating is −20 to 300 F. Temperature ef-

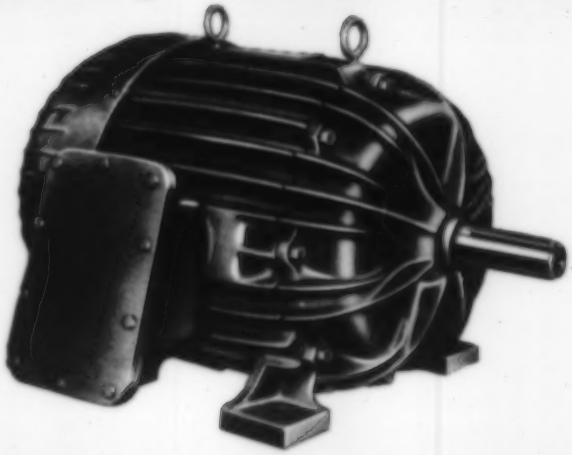


IF DUST, DIRT OR FUMES ARE IN THE PICTURE...

Arrows show how fan-driven air stream blows dust, fumes, etc. away. The radiating fins provide extra cooling.

Abrasive dust from the precision grinder won't bother these Sealedpower motors.

Specify ELLIOTT C-W Sealedpower Motors



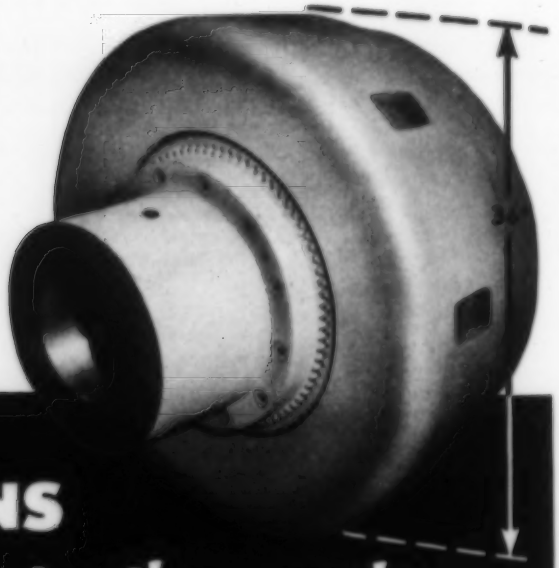
Elliott C-W Sealedpower motors are also built in approved explosion-proof design for hazardous locations.

These totally-enclosed, fan-cooled motors insure your machines against failure, production time losses and costly maintenance in dirty, exposed areas. A steady stream of cool fan-driven air keeps dust from settling on the frame and drives off the heat radiated from the finned motor casing. For extra protection, Sealedpower motors are effectively sealed against liquid penetration. Wide range of modifications such as with gear or brake, explosion-proof enclosures. Sizes 1 to 100 hp, NEMA frames. Full details in Sealedpower Motor Bulletin. Write Elliott Company, Crocker-Wheeler Division, Jeannette, Pa. for your copy.

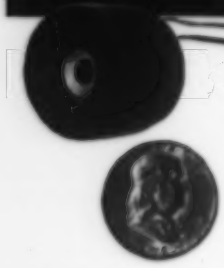
ELLIOTT Company

WB-1

TURBINE-GENERATORS · TURBINES · MOTORS · GENERATORS · DEAERATING HEATERS · EJECTORS · CONDENSERS · COMPRESSORS · TURBOCHARGERS · TUBE CLEANERS · STRAINERS



STEARNS
matched-to-the-machine
MAGNETIC CLUTCHES



For equipment ranging from business machines to ball mills — and larger.

Stearns builds clutches and clutch-brakes to fit your machine exactly—either custom-made or selected from a wide range of standard models.

Stearns clutches help increase machine efficiency, and reduce production costs. Here are some reasons why:

Wide torque range: from .1 to 45,000 lb ft.

Lightweight, compact space savers. Stearns patented multiple friction disc clutches offer extremely low inertia to driven end. This is especially important when minimum slippage is desired during clutch engagement.

Simple maintenance. Few wearing parts — no toggles, pins, yokes, shifters to wear and get out of order. Lining wear increases torque, making frequent adjustments unnecessary.

Easy adjustment. No set screws, cams, wedges, spacers or lock nuts. Simply depress adjustment lock pin, rotate armature to next notch.

Precision automatic control through push buttons, electric-eye systems, remote switches or manual controls. Widely adaptable — DC or AC with rectifier.

Varied designs. Through shaft, split shaft, duplex for two speed drives, forward and reverse drives — other special applications.

For full details consult your 1955 Sweet's Product Design File or write for Bulletin 226-D. 1144

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 692 S. 28th Street, Milwaukee 46, Wis.

New Parts

fect on calibration is less than 1 per cent per 100 deg F, and static pressure effect is less then 1 per cent per 1000 psi. Overrange protection is ±1500 psi. **Fischer & Porter Co.**, Hatboro 35, Pa.

Circle No. 127, Page 221, for more data

Silicone Lubricants 128

in fluid and grease form

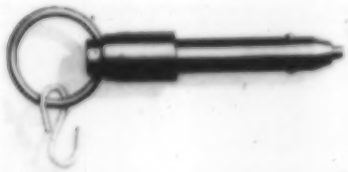
Versilube F-50 silicone lubrication fluid and G-300 silicone grease are similar in performance characteristics to petroleum oils and greases. Operating temperature range is −100 to more than 400 F. Both the fluid and grease show a comparatively small change in viscosity or consistency over this range. The lubrication fluid, suitable for use in hydraulic systems, is a silicone polymer which offers lubricity, low pour point, good temperature-viscosity properties and inherent high temperature stability without the use of additives. **General Electric Co.**, Silicone Products Dept., Waterford, N. Y.

Circle No. 128, Page 221, for more data

Quick-Disconnect Pins 129

improved for easier insertion

Strong, continuous pull ring and a spindle lock which extends beyond the tip are improvements made in B series PIP pins to facilitate insertion and removal under conditions where loads or hole misalignment could cause binding. A blow on the protruding head or tip

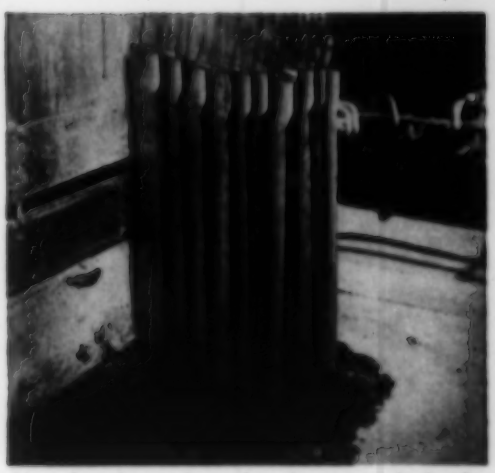


shifts the inner spindle; locking balls recede into the body of the pin, and the pin moves with the blow for easy installation or removal. Made of high strength material, the pins are available with T, L and button type head styles in sizes specified by most bolt standards. Pins are suitable for bracket, clevis, tube joining or similar uses. **Aviation Developments Inc.**, 210 S. Victory Blvd., Burbank, Calif.

Circle No. 129, Page 221, for more data

Cutter blade of Crucible alloy steel.

First step in manufacture of cutter blade. Crucible beveled blade alloy steel is fed through this 100-ton press, where it is cut to length and holes punched.



Next, lengths are formed to shape on a hydraulic press, and then given a tempering bath as shown.

CRUCIBLE ALLOY STEEL *cuts blade damage in rotary mowers . . .*

Lawn-Boy mower. Built by RPM Manufacturing Co., Lamar, Mo., a subsidiary of Outboard, Marine & Manufacturing Company, maker of Johnson & Evinrude outboard motors.

Rotary lawnmower cutter blades, whirling at high speeds, often hit small rocks or bits of trash. Ordinary steels just can't take that sort of rugged treatment. They chip, crack – wear out far too quickly. That's why in leading mowers, like the new *Lawn-Boy*, you'll find special *alloy* steel cutter blades *designed for reliable performance.*

For Crucible has developed a *special alloy steel* made to give the best possible combination of toughness and hardness for long-lasting edges—and formability and ductility for ease of manufacture. It's been so successful that *Crucible is now the largest producer of lawnmower steels.*

Most Crucible steels are designed to fill *special* needs. If you have an application where ordinary steels won't do, come to Crucible. Take advantage, too, of the dozens of technical booklets and data sheets Crucible has prepared to help you make the best use of special steels. For a free publication catalog, write *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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The BALL BEARING for your

LINEAR MOTIONS

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A or Low-Cost Series B BALL BUSHINGS.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Improve your product. Up-date your design and performance with BALL BUSHINGS!

Now manufactured for ¼", ½", ¾", 1", 1½", 2", 2½", and 3" shaft diameters.

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ELIMINATES BINDING AND CHATTER
SOLVES SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

Progressive Manufacturers Use Ball Bushings —A Major Improvement at a Minor Cost

THOMSON INDUSTRIES, Inc.

Dept. E, MANHASSET, NEW YORK

Write for descriptive literature and the name of our representative in your city.

Also manufacturers of NYLINED Bearings — DuPont NYLON within a metal sleeve—for rotation and reciprocation.

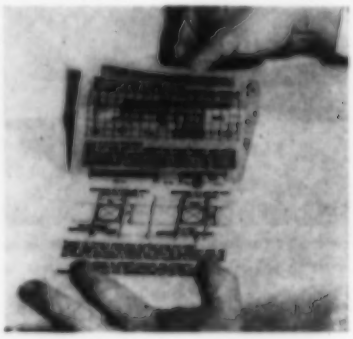
ENGINEERING DEPARTMENT

EQUIPMENT

Drafting Details 130

frequently used sections printed on adhesive sheets

Title blocks, specification and revision boxes, instructions, symbols, drawings of standard and special components and cross-sections used frequently in drawings are reproduced on matte-surfaced acetate sheets. Made with adhesive on



either the front or back, the reproductions are pressed onto the drawing by hand after removal of a protective paper coating. One or several details can be printed on a sheet, and blank sheets are available to permit the use of nonstandard, typed information on drawings. The adhesive used is heat resistant and is not affected by any reproduction process. **Stanpat**, Whitestone 57, N. Y.

Circle No. 130, Page 221, for more data

Portable Voltmeter 131

transistorized unit is powered by batteries

Portable transistorized voltmeter covers frequencies from 20 cps to 1 mc. It is stable at all operating temperatures from 0 to 120 F. Accuracy is ±5 per cent. Peak sensitivity is 0 to 1 mv, and any of 12 decade, or 10 db, ranges can be switched on the front panel. A 10-megohm input impedance on all ranges prevents disturbances to circuits under test. The front panel meter reads direct from −20

FLETCHER MINING EQUIPMENT REPORTS ON CHIKSAN SWIVEL JOINTS

LONG, SERVICE-FREE LIFE DESPITE EXTREME ABRASIVE DUST AND MECHANICAL ABUSE

When it comes to rugged service, the Fletcher Roof Drill really puts Chiksan Swivel Joints thru the paces. Installed on hydraulic lines where operating pressures run as high as 1800 psi, the Swivel Joints are used to minimize torque and eliminate knotting on lines as the bit is raised and turned. The Swivel Joints are subjected to extreme mechanical abuse and abrasive dust as the hard working drill bores a hole, then installs and tightens roof bolts in underground mines.

Yet with all of the extreme abuse and abrasive coating, the J. H. Fletcher Company reports Chiksan Swivel Joints continue to provide free swiveling action with exceptional maintenance-free service.

Assure yourself of this long-life, trouble-free service, by specifying versatile Chiksan Swivel Joints in your plant and equipment.

Chiksan Swivel Joints rotate 360° in 1, 2, and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

CHIKSAN

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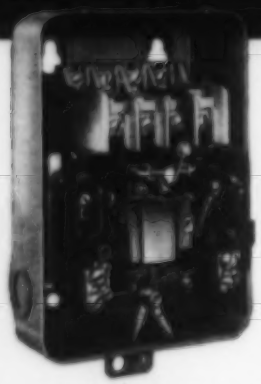
Another
FURNAS "FIRST"
"DUAL SEAL" COILS



FEATURES

- Moisture and Fungus Resistant
- Excellent Heat Dissipation
- Dimensionally Stable
- Mechanically Stronger
- Non-combustible

Furnas Electric again leads the field —this time with magnetic controls with Dual Seal coils for longer control life. Dual Seal molded coils are moisture and fungus resistant, dimensionally stable, age resistant, will not support combustion and have high dielectric strength. Their mechanical properties eliminate the damage often caused by vibration or impact.

DUAL VOLTAGE COILS

Coil changing is virtually eliminated and stocking of coils simplified with the new Dual Seal dual voltage coils. For example, on 5, 7½ or 10 hp. starters, one 220-440 volt Furnas Electric coil is used where six are normally required.

Write today for free 140-page Catalog 101. Furnas Electric Company, 1045 McKee Street, Batavia, Illinois.

FURNAS ELECTRIC COMPANY
BATAVIA, ILLINOIS
Sales Representatives in all Principal Cities

Engineering Equipment

to +2 db, or from 0 to 1 or 0 to 3 v. Voltage calibration is linear. Output terminals are provided for use with monitoring devices with input impedances of 10,000 ohms and higher. Weighing 30 oz, the instrument is enclosed in a 5-in. high plastic case. Power is from three standard batteries which provide over 35 hours of continuous operation. **Alto Scientific Co.**, 855 Commercial St., Palo Alto, Calif.

Circle No. 131, Page 221, for more data

Rapid-Sequence Camera 132

takes 5 to 20 pictures per second

This 70-mm rapid sequence camera provides 2½ x 2¼-in. negatives at rates of 5 to 20 per second. An adjustable focal plane disk type shutter has variable exposure settings from 1/25 to 1/2880-second. The camera weighs 12½ lb and can be held in the hand or mounted on a tripod. It is equipped with automatic reflex focusing and will accommodate lenses from 3 to 80-in. focal length. A small 12-v battery provides electric power, but the camera can be adapted for operation on other voltages. A 100-ft

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2. It is turning more and more to automatic production.
3. Increasing mechanical problems have to be met in the development of advanced electronic equipment.

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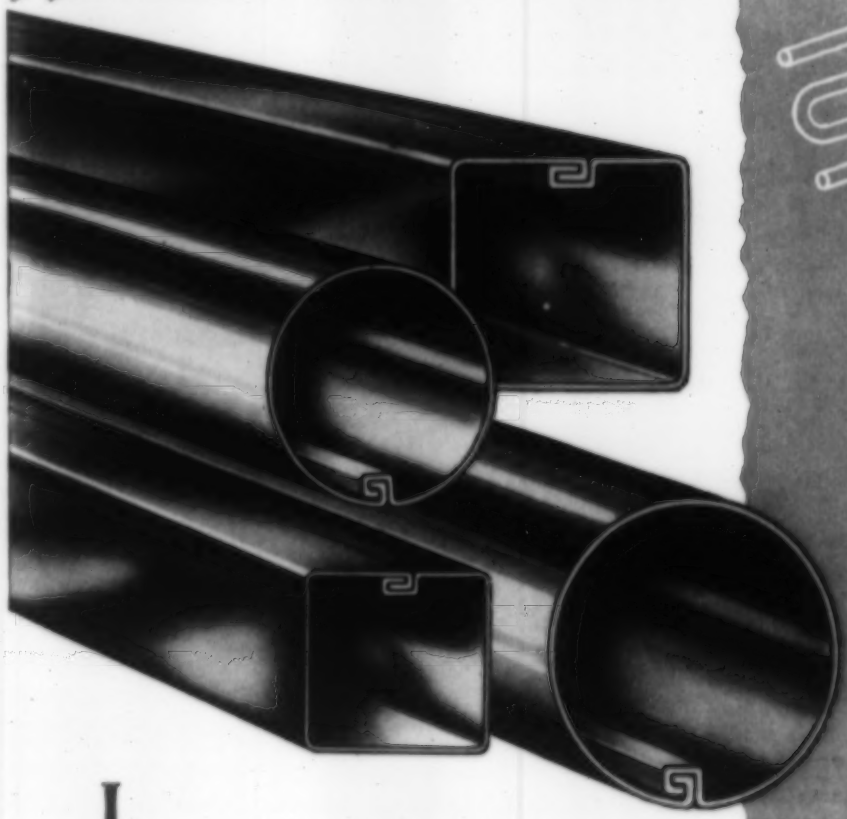
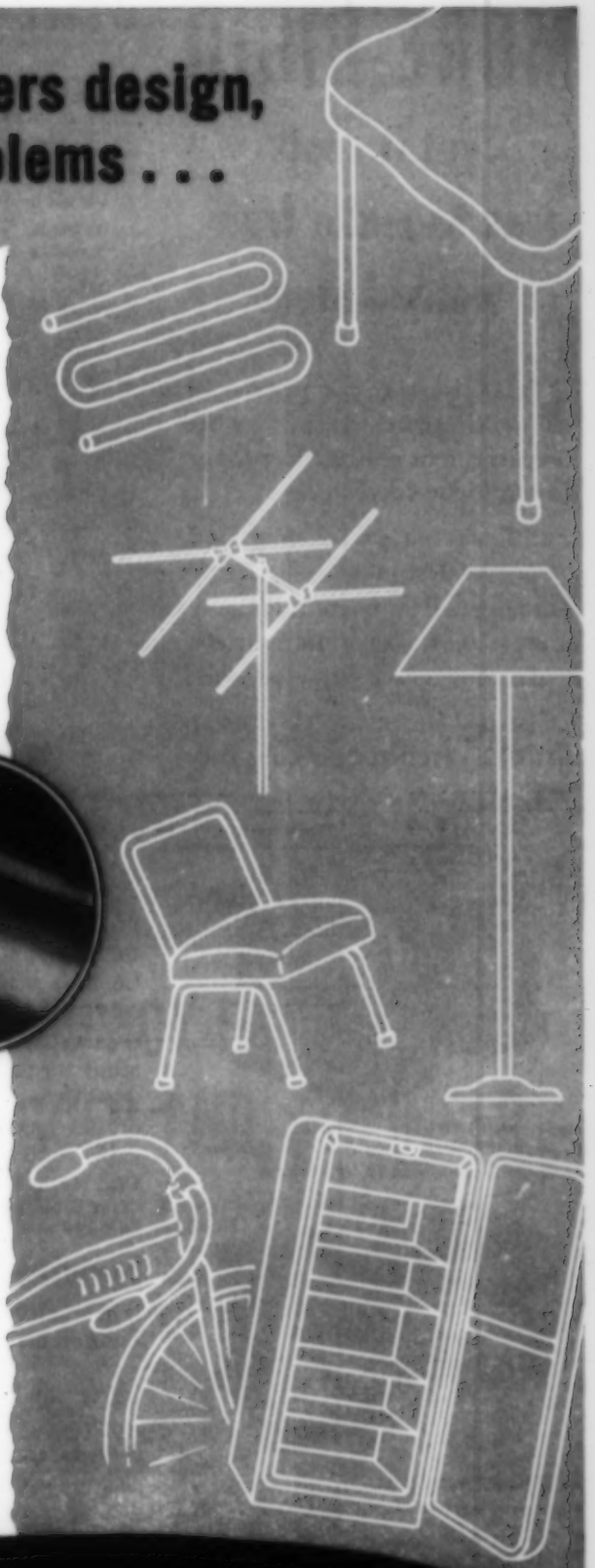
Roll Formed Tubing answers design, production and cost problems . . .





Less expensive Roll Formed Lockseam Tubing cuts costs on all tubing jobs. In many cases it does a better job than more expensive tubing. Lockseam Tubing can be bent as easily as other types. Your tubing is delivered ready for use. Send us your blueprints for steel or aluminum Lockseam Tubing. Let us prove that Roll Formed can help you produce a better product at less cost. For complete details on Roll Formed tubing and special shapes write for Catalog 1053. It tells the complete Roll Formed story.

ROUND SIZES — LOCKSEAM TUBING

Section No.	Wall Thickness	O.D.	Section No.	Wall Thickness	O.D.
2172	.018	½"	2096	.025—.030—.035	1"
2173	.018	⅝"	2020	.025	1⅛"
2103	.025—.030	¾"	2030	.030—.035—.040	1¼"
2174	.025—.028—.032	⅞"	2176	.030	1½"

ROLL FORMED PRODUCTS
COMPANY

MAIN OFFICE AND PLANT · 3754 OAKWOOD AVE., YOUNGSTOWN, OHIO

MORE RIGID

...yet it costs less to make from welded steel

THIS base for a precision drilling machine shows what benefits can be realized by proper design for welded steel.

40% less material is now used ... yet the design is considerably more rigid. Alignment tolerances of .017" on the original base are held to .002" in the welded design.

The cost is considerably lower than the original cast construction.

Fig. 1. Welded Steel Base *for Wales-Strippit Company, N. Tonawanda, N. Y. Designed using the Lincoln WELDesign System.*

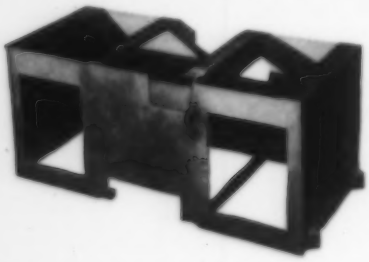


Fig. 2. Former Design *had cast sections that were shipped in parts and aligned in customer's shop.*

Savings like these can be duplicated on your products. Have a Lincoln representative show you how to benefit. Write.

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The World's Largest Manufacturer of Arc Welding Equipment

Engineering Equipment

roll of film provides 470 pictures. The camera is also available for pulse or single-frame operation at rates up to 5 per second. **Charles A. Hulcher Co.**, 40 Manteo Ave., Hampton, Va.

Circle No. 132, Page 221, for more data

Spring Motor Model 133

exerts 6-oz tension on output cable

To aid design engineers in development of mechanisms based on the Neg'ator constant - torque spring motor, this small working model of the B-motor form of

the spring is offered. Smaller than previously offered model, this motor is mounted on 1 x 1¾-in. plastic base and exerts a nominal 6-oz tension on the output cable as it is extended through 36 in. Constant torque of 0.11-lb-in. is developed through 20 revolutions of the output bushing at all positions of cable extension. **Hunter Spring Co.**, Neg'ator Div., Lansdale, Pa.

Circle No. 133, Page 221, for more data

Operational Amplifier 134

has balanced differential inputs

Using this plug-in type high gain amplifier as a base subassembly permits assembling feedback computing devices of all speeds with

Before You Give Up...

consider a ball

Your wastebasket knows how a design job is going . . . "You're on the wrong track," it says when it looks like the one above. "You need a fresh approach."

"Maybe you should consider a ball . . ."

A *Universal* ball.

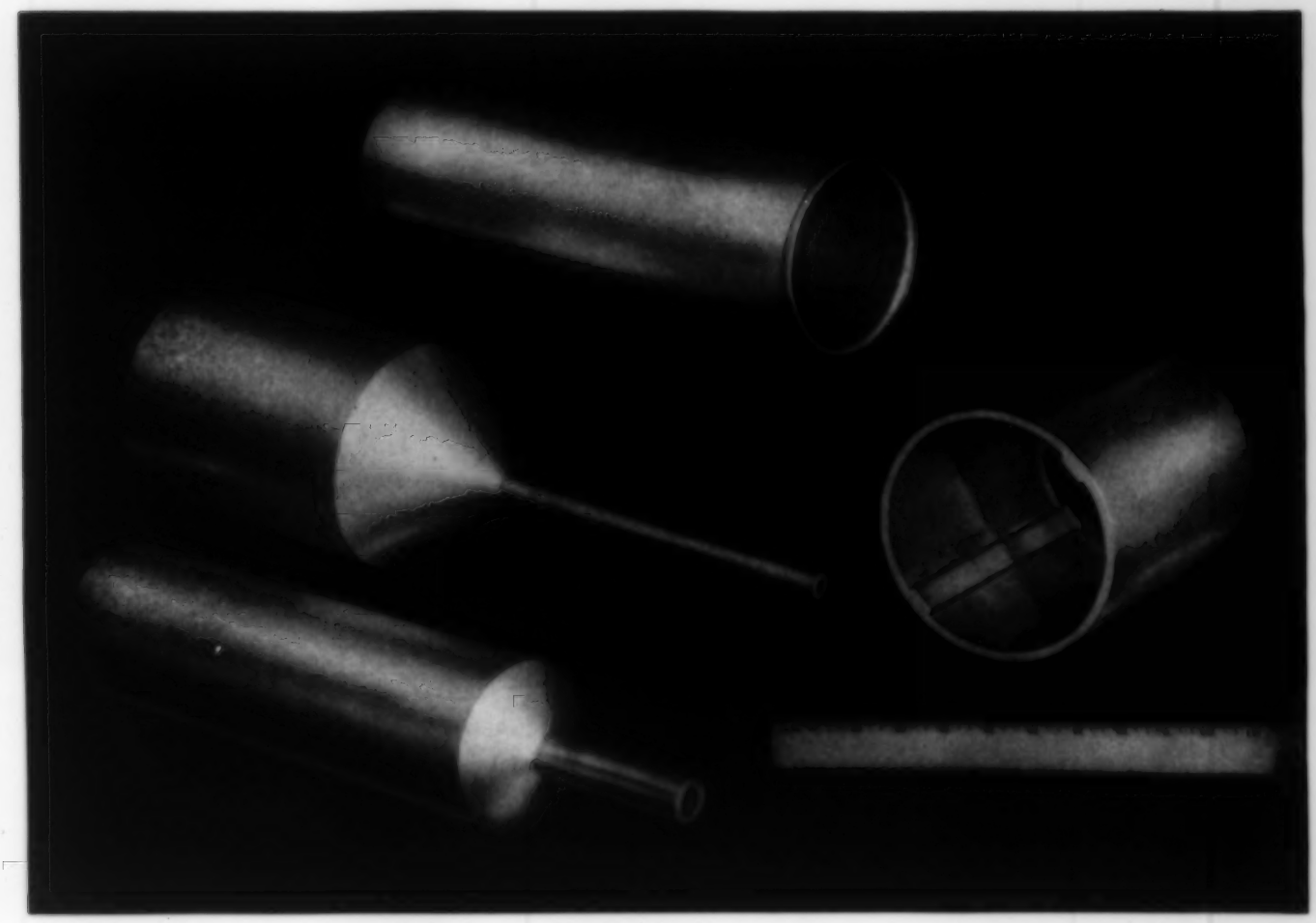
A Universal ball so tiny you can hardly see it. Or a Universal ball as big as a golf ball. There's a size for every need —including the *new* demands for today's new uses. For these days, designers and manufacturers are continually coming up with new products and new jobs for balls in every industry in the country.

From smallest to largest, Universal balls are as perfectly round as long experience, close quality control, and skillful workmanship can produce. Tolerances within 10-millionths of an inch. And we can supply just about any kind of metal you wish.

Next time your wastebasket starts working overtime, and you see where a ball might make an "impossible" job possible, call us in. Maybe we can help.

Universal Ball co.

WILLOW GROVE
MONTGOMERY CO., PA.



SEE WHAT'S HAPPENED TO IMPACT EXTRUSIONS; ALCOA CAN MAKE THEM BIGGER AND STRONGER

(and with more complex design details than ever before)

People who think of aluminum impact extrusions only in terms of tooth-paste tubes are in for a shock these days. Hydraulic cylinders for jet aircraft are Alcoa Impacts. Complete electric motor housings are Alcoa Impacts. Parts as long as 18 inches, parts weighing up to 10 pounds are now made as Alcoa Impacts.

In the thousands of production applications where Alcoa Impacts are practical, they offer special advantages over other forms of fabrication. Lighter than a forging, stronger than a machined part, sounder than a casting, faster than weldment . . . and part for part, Alcoa Impacts cost less.

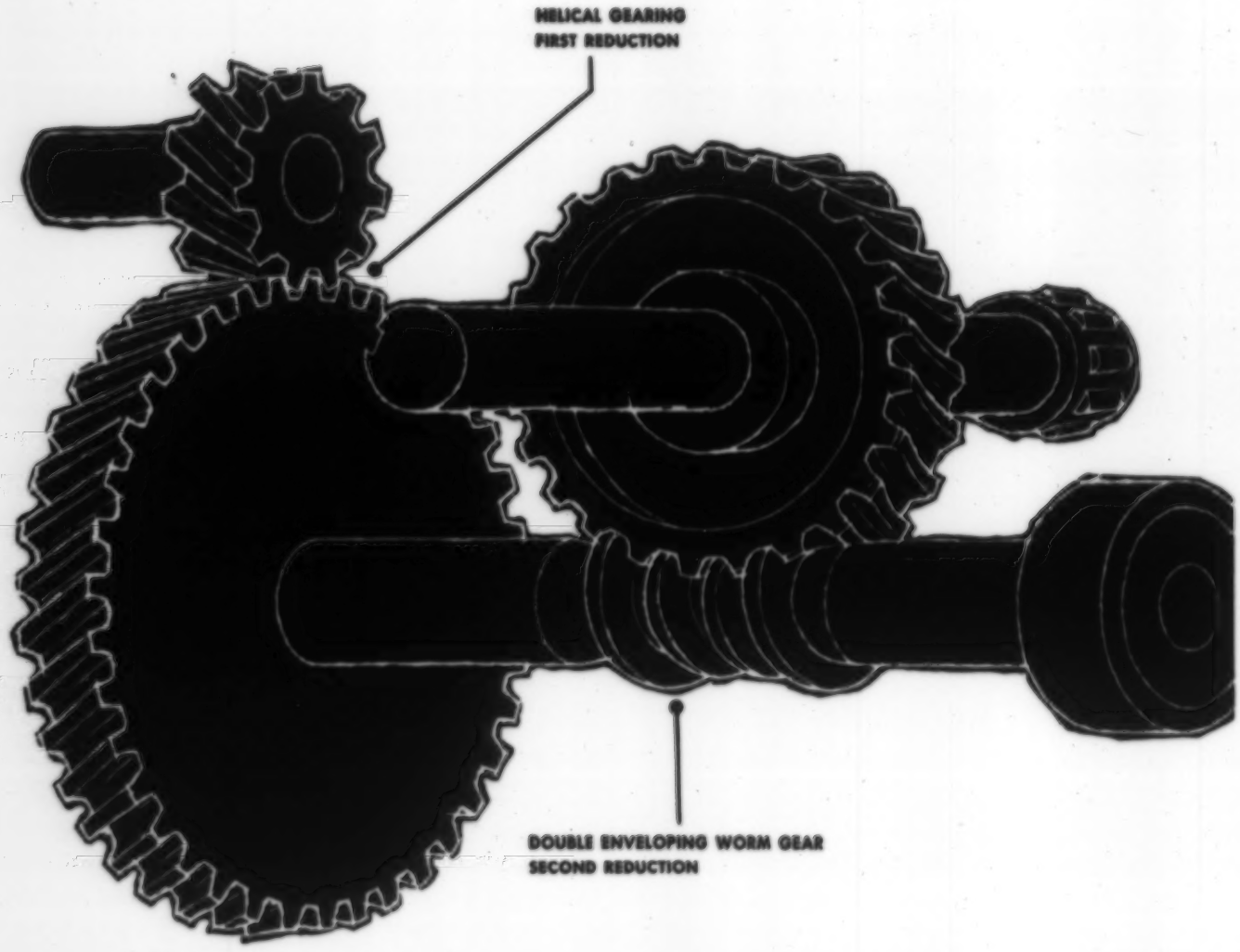
These days you can expect tensiles up to 75,000 psi, surface finishes of 40 to 250 microinches, length-to-diameter ratios as high as 12 to 1.

Where can you use Alcoa Impacts? Your local Alcoa sales engineer represents Alcoa's complete impact extruding facilities, and will be happy to help you investigate the many cost-saving design possibilities which Alcoa Impacts offer. For complete design information, write Aluminum Company of America, 1991-M Alcoa Bldg., Mellon Square, Pittsburgh 19, Pa.

Your Guide to Aluminum Value

ALCOA ALUMINUM

Fasten Aluminum With Alcoa® Aluminum Fasteners



How Westinghouse new right-angle gearmotor delivers 32% more power

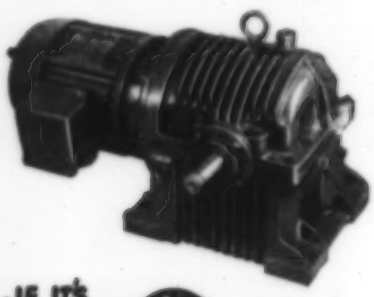
With this exclusive match of gearing, Westinghouse right-angle gearmotor gives you top horsepower and rugged dependability at the lowest cost. It's the result of skillful use of helical gearing to gain maximum efficiency from high lead-angle worm gearing. Over a range of speed reduction, from 20:1 to over 100:1, the Westinghouse right-angle gearmotor *averages* 32% more power than conventional single-reduction, worm gearmotors. At a ratio of 60:1 you actually get 98% more power.

Greater dependability and long life result from Westinghouse exclusive double-enveloping worm gear. It provides 330% more gear-tooth area to support the load. As wear occurs, only double-enveloping gears regenerate or reproduce themselves.

In application, Westinghouse design for high overhung load capacity requires no outboard support. Right-angle gearmotors are available in a complete range of AGMA output speeds and Life-Line® "A" motor enclosures.

FREE detailed facts about Westinghouse new right-angle gearmotor in booklet B-6579. Call your local Westinghouse Sales Office or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-07349



YOU CAN BE SURE...IF IT'S Westinghouse

simple wiring. The unit, designated model K2-X, has balanced differential inputs for minimum drift and maximum utility, high performance and economical operation. Feedback operations which can be performed include addition, subtraction, integration, differentiation, proportioning, inversion, impedance-conversion and the injection of current. Gain is 30,000 dc, open-loop; power requirements are 7.5 ma at +300 v dc, 5.2 ma at −300 v dc; voltage range is −100 to +100 v dc for output. The amplifier has an octal plug type base. It is 4½ in. high and weighs 3 oz. **George A. Philbrick Researches Inc.**, 230 Congress St., Boston 10, Mass.

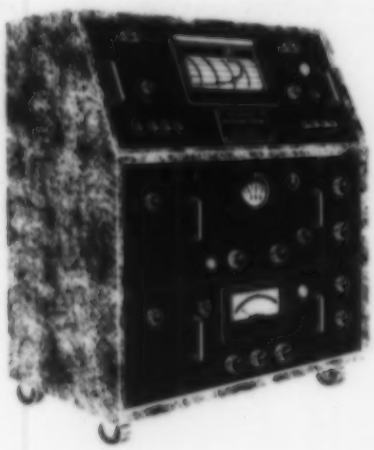
Circle No. 134, Page 221, for more data

Impedance Plotter 135

for frequency range of 10 cps to 100 kc

This automatic impedance plotter is designed for instantaneous recording of real and imaginary components of impedance as a function of frequency, temperature or other variables. Frequency range is 10 cps to 100 kc, with a rated accuracy of ±2 per cent. Resistance range is 0 to 10,000 ohms; reactance range, ±10,000 ohms. Power input is 115 v, 60 cycles, 400 w. The plotter employs a Mosely Autograf recorder which plots on standard 8½ x 11-in. graph paper. The zero can be located anywhere on the paper, or suppressed. **Chesapeake Instrument Corp.**, Shadyside, Md.

Circle No. 135, Page 221, for more data



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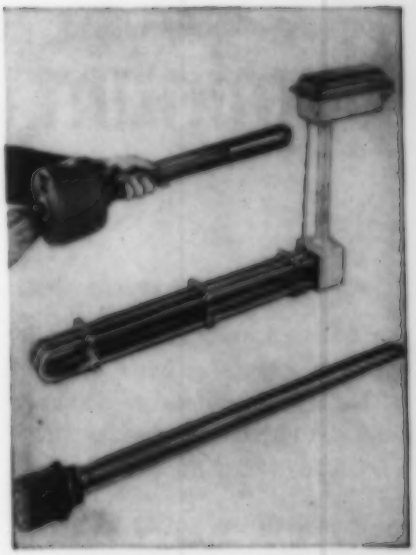

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with or without built-in thermostats

. . . fit the heat to your need up to 100,000 watts and 2,500 psi

Full range of sizes and ratings in portable, screw-plug and flanged types. Available with copper, steel or alloy sheaths to resist corrosion.

Used for heating water, asphalt, greases, molten salts, pickling and plating baths, process kettles; for superheating steam and compressed air; for melting lead, solder, babbit; and for a wide range of similar applications.

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☐ a copy of "101 Ways"
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Company _____
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A-4467A

Aluminum cuts costs on three screw

$54.42 SAVED!

Two case pillars per clock. Cost of parts for 10,000 clocks:

Brass		$96.00
Less scrap recovery	6.66	
		$89.34
Aluminum	$35.84	
Less scrap recovery	.92	
		34.92
SAVED WITH ALUMINUM		$54.42

$69.90 SAVED!

Three movement pillars per clock. Cost of parts for 10,000 clocks:

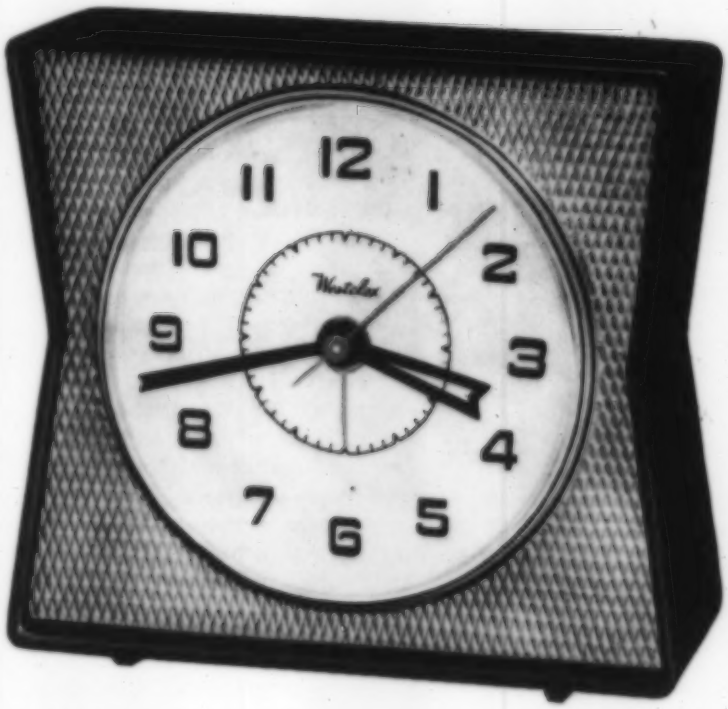
Brass		$120.96
Less scrap recovery	12.48	
		$108.48
Aluminum	$ 40.32	
Less scrap recovery	1.74	
		38.58
SAVED WITH ALUMINUM		$ 69.90

$9.08 SAVED!

One hour wheel bushing per clock. Cost of parts for 10,000 clocks:

Brass		$32.16
Less scrap recovery	12.49	
		$19.67
Aluminum	$12.32	
Less scrap recovery	1.73	
		10.59
SAVED WITH ALUMINUM		$ 9.08

machine parts for WESTCLOX



WESTCLOX MANAGEMENT SAYS:

"We recommend that aluminum be used in all cases where it can save us money, as it does with the three parts shown here. Lower raw material costs without any sacrifice in machining time is the main reason for the savings we get with aluminum."

WESTCLOX ENGINEERING SAYS:

"In addition to its economy, we find that aluminum is often more suitable for certain parts than brass or steel."

WESTCLOX PRODUCTION SAYS:

"We find that aluminum screw machine stock machines easily and has equal or better machining rates than other metals. No special tooling or other preparation is required."

THE EXPERIENCE of Westclox, Division of General Time Corporation, is more evidence of this important fact: when you specify *aluminum* screw machine parts you often get *better* parts for *less money*.

A pound of Kaiser Aluminum screw machine stock gives you *three times* as many parts as a pound of brass or steel. And these parts provide you with a unique combination of advantages, including lightness with strength, handsome finish, corrosion resistance, good heat and electrical conductivity.

For more information or assistance, look for our local number in the classified telephone directory under the heading "Aluminum" or contact one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

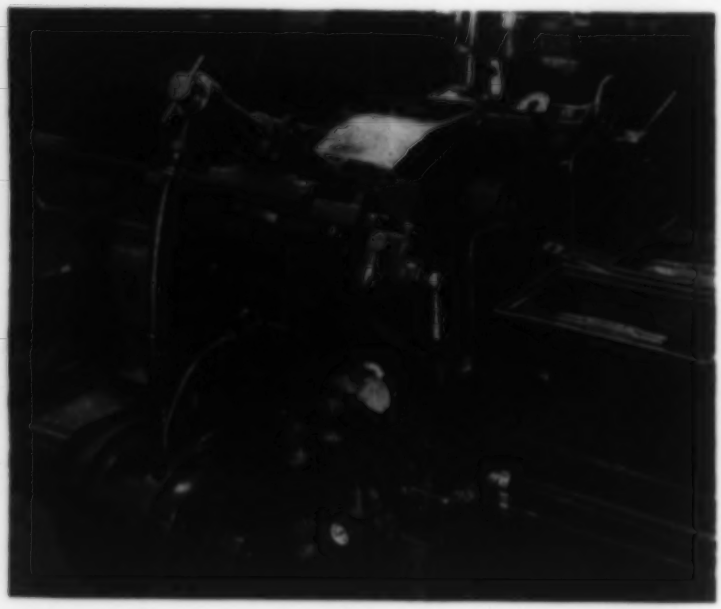
WRITE FOR VALUABLE LITERATURE!

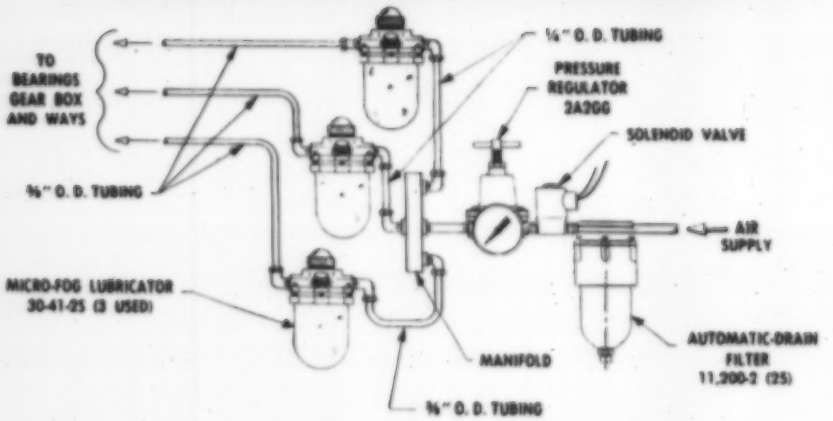
Product catalog contains Kaiser Aluminum availabilities, specifications, alloys. See in Sweet's File for Product Designers or write for your copy to: Industrial Service Division, 6122 Kaiser Building, Oakland 12, California.

Norgren MICRO-FOG

completely lubricates centerless grinder with only 12 drops of oil per minute

Here's another typical example of how Norgren Micro-Fog provides more efficient, automatic lubrication with minimum costs. Micro-Fog, replacing a pump recirculating system on the centerless grinder, uses only 12 drops of oil per minute to lubricate the drive bearings, thrust bearings on wheel spindle, journal bearings, gear change box, journal and thrust bearings on back up wheel, and two sets of ways. A unique system of chevron grooving in drive shaft bearing aids in Micro-Fog distribution.





THE NORGREN MICRO-FOG LUBRICATION EQUIPMENT

For complete details on this Micro-Fog application write for Blueprint MF 15 or phone the Norgren representative listed in your telephone directory classified section under Norgren Pneumatic Products.

C. A. Norgren CO.
3442 So. Elati, Englewood, Colo.

THE ENGINEER'S Library

Recent Books

Mathematics of Engineering Systems. *By Derek F. Lawden, senior lecturer in mathematics, College of Technology, Birmingham, England; 380 pages, 5½ by 8½ inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $5.75 *postpaid.*

First published in 1954, this text gives an account of several mathematical methods used to analyze the behavior of various physical systems. It was prepared for use in the fields of electronics, electrical engineering, applied physics, and instrument technology.

The book first deals with linear differential equations with constant coefficients. It then goes into Fourier analysis, and concludes with a discussion of nonlinear differential equations.

Although the emphasis is on these mathematical methods, the book does not view them entirely from the abstract. Each is employed to solve a number of practical engineering problems, with other possible uses suggested by practically slanted exercises.

•

Handbook of Engineering Materials. *Edited by Douglas F. Miner and John B. Seastone; 1394 pages, 5½ by 8½ inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $17.50 *postpaid.*

This handbook is intended as a single source of information on selection and use of the usual materials of manufacturing and construction. It is arranged by classes of related or similar materials to aid in selection of materials for particular applications. This grouping facilitates choice of materials based on properties, adaptability to fabricating methods, avail-

HOW *Norgren* **Spray-Lube** *System* **CAN SIMPLIFY DESIGN OF MACHINE TOOLS**

and provide many profitable advantages for users

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installed Spray-Lube on tapping machine...

- **increased tap life**
- **increased tapping speed**
- **eliminated problem of chips plugging coolant lines**
- **eliminated messy condition of splashing coolant**

A-P adds 3 more

Since this installation A-P Controls has added Spray-Lube to three other machines.

Machine taps 12 holes of various sizes simultaneously. Norgren Spray-Lube System includes 5 gal. tank, 12 mixing valves and spray nozzles. Air and liquid line pressures are 42 psi and 44 psi, respectively.

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"ON THE JOB"

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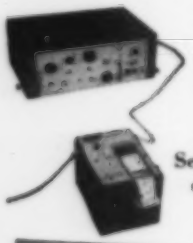
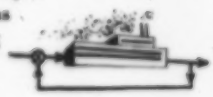


PRODUCTION TESTING

of components is accomplished by a Servo Component manufacturer by means of a Sanborn Single-Channel Recording System with a Sanborn Servo Monitor Preamplifier.



DYNAMIC PERFORMANCE

of valves when equipped with a certain pneumatic Valve Positioner is determined by the manufacturer with a Sanborn Two-Channel System and Sanborn Carrier Amplifiers.

ACCELERATION and TORQUE

are recorded simultaneously by an oil company in their study of fuels and lubricants as they relate to engine performance.

DRONE MISSILE

manufacturer can simulate the flight of the missile and derive information concerning its behavior under certain conditions by means of an analog computer and a Sanborn Four-Channel System with four Sanborn AC-DC Preamplifiers.

ATOMIC REACTOR

to be used for power generation in prototype plant is studied with the help of a Sanborn Eight-Channel System which records the output of thermocouples, strain gage pressure pickups, and resistance devices.

ANALOG COMPUTING

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Sanborn 150 Features Include:

- Inkless Recording in True Rectangular Coordinates
- Preamplifier Interchangeability
- Eleven Types of Preamplifiers
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The Engineer's Library

ability, costs and limitations.

Section 1 covers general information such as specifications and standards, statistics in application of materials, and mathematical and physical tables. Section 2, on metals, includes ferrous metals, aluminum, magnesium, copper and alloys, zinc, nickel and alloys, other pure metals, and special-purpose metals and alloys. Section 3, on nonmetals, discusses wood and wood-base materials, paper, fibers, plastics and rubbers, organic finishing materials, fuels, carbon products, ceramic materials, industrial chemicals, and lubricants. Section 4, on construction materials, covers cements and concrete, roadbed materials, timber, rope, foundations, weather and moisture protection, and glass products.

•

Helical Spring Tables. *By John D Gayer and Paul H. Stone Jr.; 165 pages, 6 by 9 inches, clothbound; published by The Industrial Press, New York; available from* MACHINE DESIGN, $5.00 *postpaid.*

This book provides tabulated data for a wide range of compression and tension springs. It is intended to be used in determining initial space requirements of springs and can serve as a starting point in designing springs to final specifications. One section of the book pertains to compression springs arranged by coil diameters from ⅛ to 4 in. Another section covers tension springs arranged by coil diameters from ⅛ to 2 in. Sections preceding these contain instructions for using the tables.

•

Turboblowers. *By A. J. Stepanoff, Ingersoll-Rand Co.; 377 pages, 6 by 9¼ inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $8.00 *postpaid.*

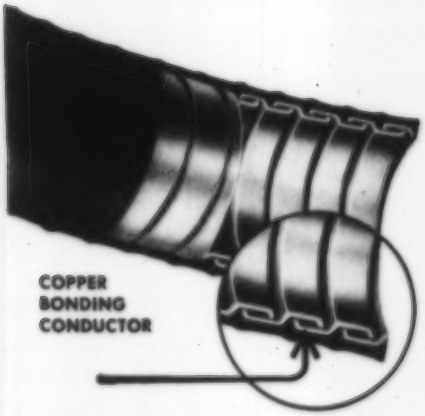
Theory, design and application of centrifugal and axial-flow compressors and fans are covered in this book which deals with both

14 SEALTITE ASSEMBLIES — one for each piece of electrical gear—is used on this control panel for air washer of interior enamel spray booth. Sealtite permits quick replacement of parts—eliminates the need to rip out and replace rigid conduit.

EVERY MOTOR connection at prime coat spray booth and bake oven is a Sealtite assembly. Motor replacement can be made in a jiffy.

SEALTITE for three motor and one snapswitch connection at this automatic conveyor helps keep "down-time" down when gear is moved.

Ford cuts "down-time," simplifies equipment change with SEALTITE flexible, liquid-tight conduit



TYPE U. A. Sealtite is approved by Underwriters' Laboratories for service in wet spots. Copper conductor wound spirally inside conduit for positive ground. Type E.F.† (not shown) is extra flexible. Meets J.I.C. standards. Available in machine tool gray at no extra cost from mill stocks.

†Pat. Applied for

Every electric motor, every snap acting switch, every motor control, every piece of electrical gear in the new Ford San Jose plant is connected with Sealtite* *flexible, liquid-tight conduit!*

With Sealtite, it's a simple matter to disconnect the wiring at the piece of equipment to be replaced and to substitute a new unit. No rigid piping need be disassembled. Down-time is held to a minimum.

And, on the job, Sealtite absorbs motor vibration . . . and its tough polyvinyl covering gives 100% protection against dust, grease and moisture.

Count up the number of times in a year that *you* move or replace electrical equipment. Multiply this by the cost in time, labor and money. Isn't Sealtite really an *economical* buy?

Electrical wholesalers stock Sealtite in easy-to-handle coils. Buy it in long, random lengths; cut it on the job without waste. Special liquid-tight connectors by Appleton, Thomas & Betts, Gedney, and Pyle-National are available. For complete information, write for Sealtite bulletins. Address: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn.

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*Trade Mark

Insist on the original

SEALTITE

FLEXIBLE, LIQUID-TIGHT CONDUIT

an ANACONDA product

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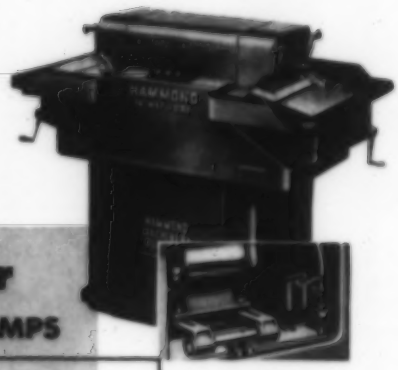

The compact, simple design of all Gusher Coolant Pumps assures you of maximum performance in a minimum of space. Wherever you mount it, a Gusher Coolant Pump is ready to go to work. There's no priming necessary, you get instantaneous coolant flow.

Gushers require little or no maintenance, the ball bearings are pre-lubricated. There is no packing to worry about and the rugged construction and dynamically balanced rotating assembly cut wear to a minimum. Always specify Gusher for your coolant needs.

Illustrated is a Hammond Model 14-WD Wet or Dry Carbide Tool Grinder — the inset shows a Gusher Coolant Pump mounted inside the base.

THE RUTHMAN MACHINERY CO.
1811 Reading Road Cincinnati, Ohio

Another of the Reasons Behind Brad Foote Quality—

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• Deburring of gears isn't normally included in specs or drawings. And we don't get paid for it. But here at BRAD FOOTE we take pains and expend many man hours on deburring—for we know that one tiny burr can ruin a $100,000 machine.

• Examine your next shipment of gears. See whether your present supplier is painstakingly removing all the burrs. Find out how many hours your assembly department has had to charge against deburring. See another way in which BRAD FOOTE quality and extra attention to details saves you money.

• Prove to yourself the savings that BRAD FOOTE quality can mean. Let us quote on the gear requirements for your next program—whether it be radar equipment, diesel engines, etc. BRAD FOOTE has experience in providing gears for almost every specialized application and would welcome the opportunity of discussing your gear problems.

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The Engineer's Library

the hydrodynamic and thermodynamic aspects of turboblower design. Past and present work in this field is summarized and a number of new methods and techniques are explored. Initial chapters treat fluid mechanics, definitions, terminology and theories for incompressible fluids. Chapters following consider general characteristics of turbomachinery, hydraulic performance of centrifugal blowers, thermodynamics of turboblowers, special problems, blower casings, leakage and mechanical losses, compression with cooling, centrifugal and axial-flow fans, multistage compressors and mixed-flow impellers.

New Standards

Letter Symbols for Gear Engineering. *ASA B6.5-1954; 9 pages, 8½ by 11 inches, paperbound; published by and available from the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, $1.00 per copy.*

Previously issued in 1949, this standard has been revised in 1955 to add three symbols: L for lead (in addition to l), r_f for fillet radius (when constant) and e subscrip for "external". The purpose of the standard is to establish uniform practice in mathematical notations and formulas dealing with toothed gearing. The principal use of the symbols is in the publication of technical literature.

•

Preferred Standards for the Presentation of Frequency Response Data. *ASME standard 107; 7 pages, 8½ by 11 inches, paperbound; published by and available from the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, $1.00 per copy.*

Containing the recommendations of the Dynamic Systems Committee of the Instruments and Regulators Division, ASME, this standard concerns the method of presenting frequency response information in the field of automatic control. The standard applies as

You can set a new High-Torque Unbrako self-locking socket set screw and forget it—it stays tight

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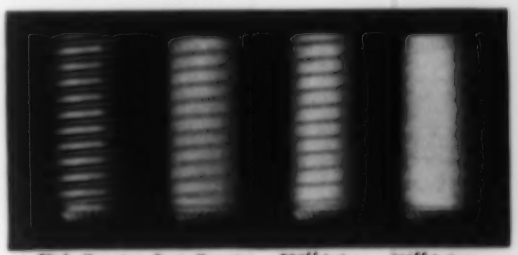
SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

ALL UNBRAKOs can withstand higher tightening torques than ordinary set screws. For example, the recommended torque for a ¼" UNBRAKO is 87 inch-pounds—40% greater than that recommended for an ordinary set screw.

These microphotographs illustrate just what fully formed threads do for the new High-Torque UNBRAKO. They make the whole screw stronger. The metal is compressed into the closely knit grain structure that you see. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

You can't buy a better set screw than an UNBRAKO. See your authorized industrial distributor today. Or write STANDARD PRESSED STEEL Co., Jenkintown 18, Pa.

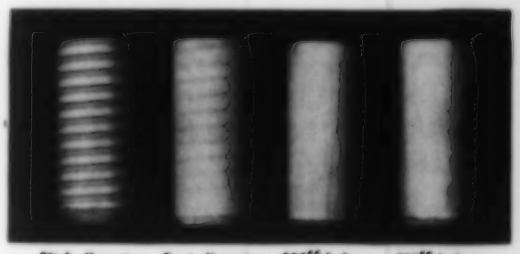
Unbrako Set Screw



Pitch diameter | Root diameter | .005" below root diameter | .010" below root diameter

Fully formed threads make the whole screw stronger. The metal is compressed into a closely knit grain structure. The grain flow follows the contour of the threads. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

Ordinary Set Screw



Pitch diameter | Root diameter | .005" below root diameter | .010" below root diameter

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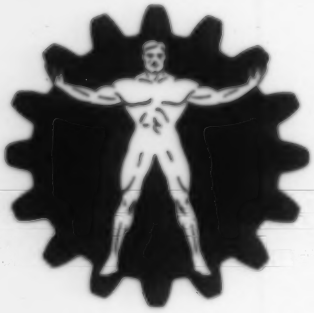

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well to all physical systems where the concern is the relation between input and output of the systems.

•

Gear Nomenclature. *ASA B6.10-1954, AGMA 112.03; 23 pages, 8½ by 11 inches, paperbound; published by and available from the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, $1.50 per copy.*

Intended to promote uniformity in gearing terms and their meanings, this standard has been revised in 1955 to present corrections, additional terms and further explanations of several definitions, and to rearrange the alphabetical index.

Association Publications

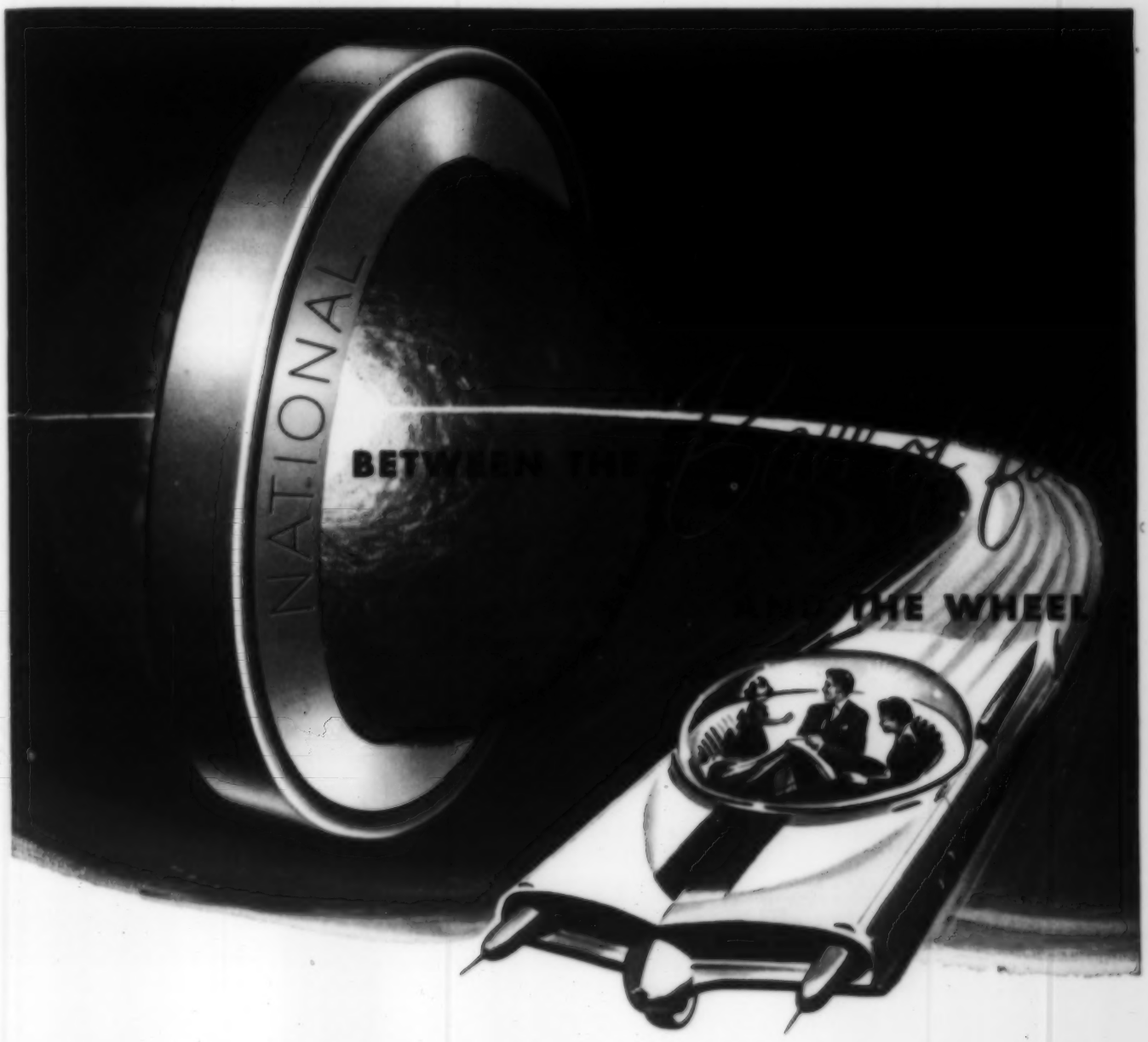
Proceedings of the Third Annual Meeting of the Standards Engineers Society. *48 pages, 8½ by 11 inches, paperbound; available from Standards Engineers Society, P.O. Box 281, Camden 1, New Jersey, $3.00 per copy.*

This booklet contains papers presented at the third annual meeting of the Standards Engineers Society, held in 1954. Subjects covered include integration of government and industry standards, international standardization, place of standardization in management, and establishing and operating a materials department.

•

How to Train Engineers in Industry. *Prepared by the Professional Engineers Conference Board for Industry in co-operation with the National Society of Professional Engineers; 72 pages, 6 by 9 inches, paperbound; published by and available from The Professional Engineers Conference Board for Industry, 1121 Fifteenth Street N.W., Washington 5, D.C., $2.00 per copy.*

This report is the result of the fourth of a series of executive research surveys. The survey reported covers more than 200 com-



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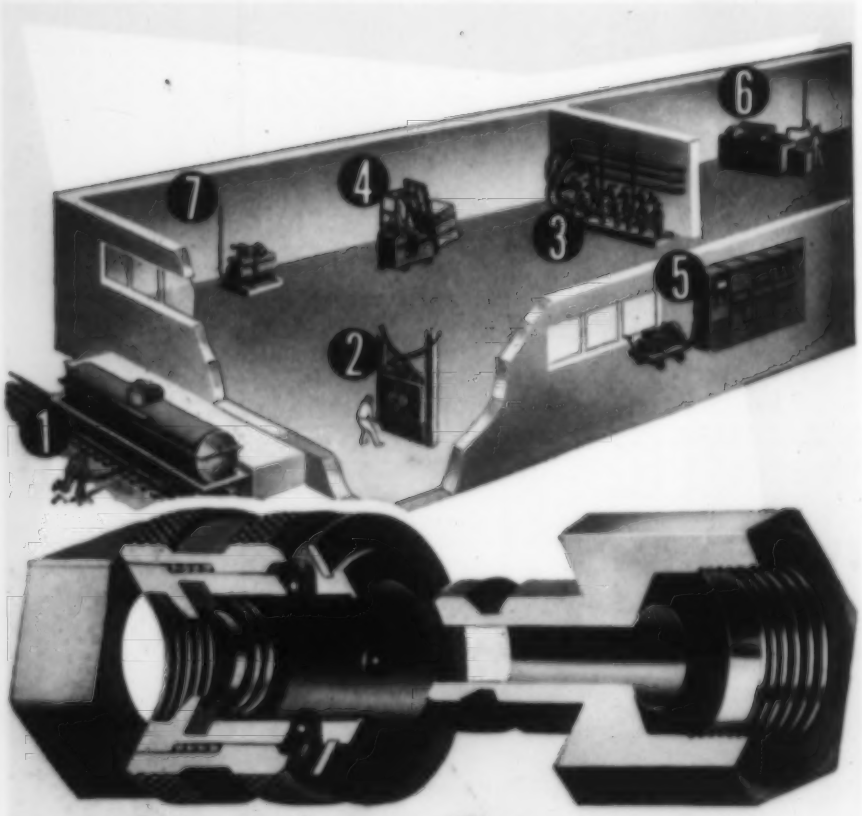

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The Engineer's Library

panies employing more than 1½ million persons, thousands of them engineers. Subjects covered are the cost of training, typical programs, training the trainers, orientation and indoctrination, rating and evaluation, training for advancement, guidance toward professionalism, and recommendations. Appendixes include a bibliography of the general subject.

•

Pipe Friction Manual. *87 pages, 8½ by 11 inches, paperbound; published by and available from Hydraulic Institute, 122 East 42nd St., New York 17, $1.75 per copy.*

This manual is intended to be an authoritative handbook on pipe friction. It features a section demonstrating mathematical calculations which are used later in the construction of charts. These are supplemented by tables of friction loss for water in feet per hundred feet of pipe. Wrought iron, steel and cast iron pipe sizes from ⅛-in. nominal to 84 in. inside diameter are covered. Formulas, friction loss moduli, friction factor charts, roughness factor charts and viscosity tables are also provided. A total of 22 references cited are the sources of the data.

Government Publications

Reference Tables for Thermocouples. *National Bureau of Standards Circular No. 561, By Henry Shenker, John I. Lauritzen Jr., Robert J. Corruccini and S. T. Lonberger; 84 pages, 7¾ by 10¼ inches, paperbound; available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 50 cents per copy.*

This booklet contains empirical tables giving the temperature-electromotive-force relationship for the various types of commercially available thermocouples. The tables provide a basis for drawing deviation curves for comparing individual thermocouples with others of their type or with instruments calibrated to read temperature directly.

Stress Relief

THE other month J. P. Henderson, writing on the group approach in technical developments, pointed out the necessity of "conforming" in many ways in order to be a co-operative worker. This reminded him of some of the salty characters who operated in technology in the old days—men who could not work in harness. He tells this month about:

Boundary Bill

Boundary Bill was an eccentric character, widely known in one of our industrial cities at the turn of the century. I knew him, but as a young duffer, I did not cross his path very often. Most of the stories of his exploits I gained through hearsay, and many of them became local legends which probably gained in the telling.

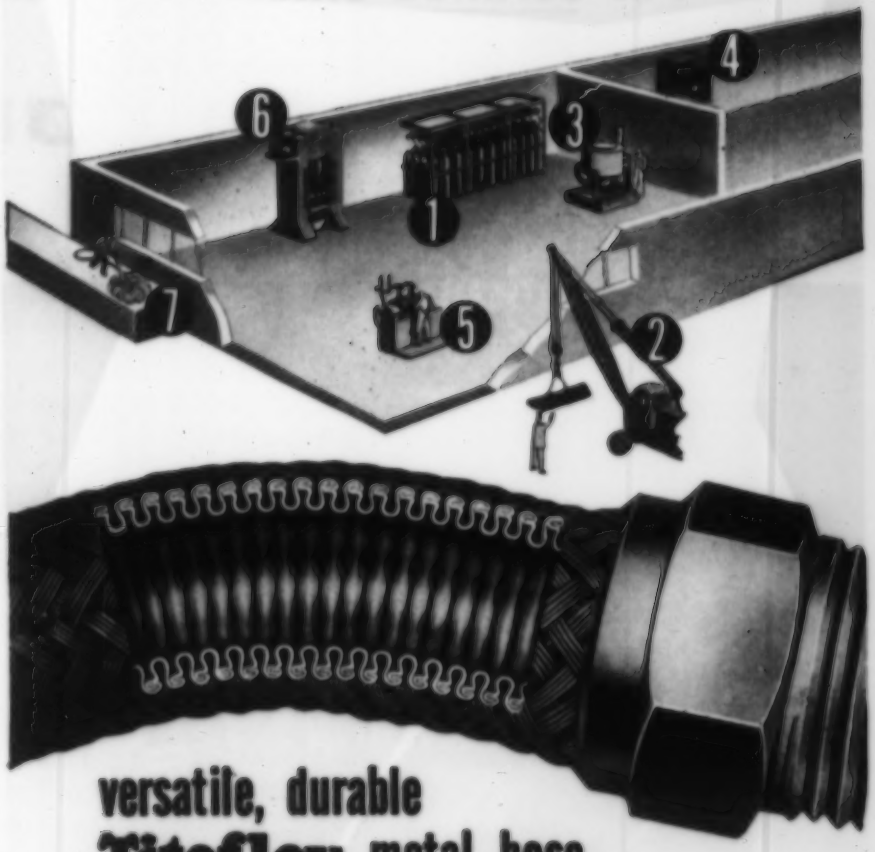
Bill won his nickname by the standard formula for tackling any problem. "Let's establish the boundaries," he would always say.

Faced with a problem on lubrication, he would try the thinnest oil he could find and also the heaviest. If both worked he would look for still lighter and still heavier samples to try. "Got to establish the boundaries." Of course he completely ruined much of the equipment on which his experiments were made.

His small tool and development shop always had a dozen gear trains in constant operation. He was trying gear-tooth contours for wear, and knew no better method than life tests. Gearing problems became one of his specialties and many local manufacturers called him in on troubles.

The big shots among the manufacturing gentry were his cronies, for he played poker and golf with them at the country club. That was the extent of his activities with the country club set, for his

(*Concluded on Page* 310)



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Can take grueling punishment from corrosive fluids, high temperatures, excessive vibration and pressures . . . or from any combination of these industrial *spoilers*. All-metal construction. Wide range of sizes. Braided or unbraided. Choice of alloys and fittings to meet *every* need.

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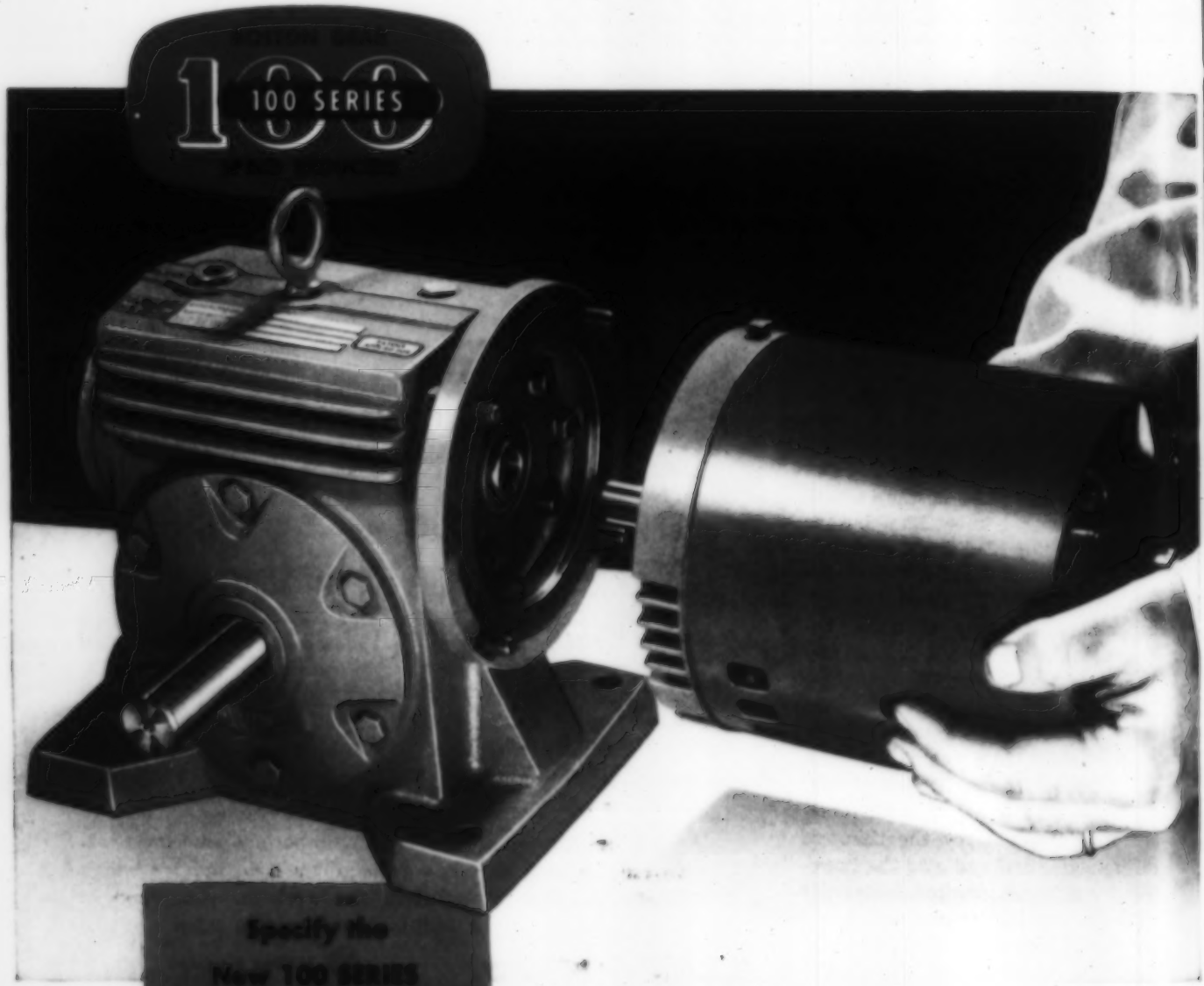

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100 SERIES
REDUCTORS

- **NEW** space saving design
- **NEW** clean contours
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- **NEW** cooling fins
- **FAN COOLING** optional on larger sizes

and unlimited adaptability –

COST-SAVING "COMBINATION"

The new 100 SERIES RATIOMOTOR combines an independent gear reduction unit and an easily detachable standard end-mounted motor.

MOTOR CAN BE REMOVED AND REPLACED in a few minutes, without disturbing the gear reduction unit. Saves maintenance time, preserves alignment, permits continued operation with spare motor.

ORIGINAL MOTOR CAN BE CHANGED When conditions require change to a motor of special characteristics (totally enclosed, explosion-proof, etc.) it can easily be attached in place of the original motor.

ANY MODEL YOU NEED – FROM STOCK The new BOSTON GEAR 100 SERIES includes 1064 different units to fit any drive need. Reductors, for mechanical drives, as well as Ratiomotors and Flanged Reductors, are *standardized stock units* sold by BOSTON GEAR Distributors, located in every industrial center of the U. S. and Canada.

TALK TO A BOSTON GEAR FIELD ENGINEER Our 76-year experience as speed reducer specialists will help you simplify planning, and put your product ahead in design. Your Boston Gear Distributor will arrange a call, or write: Boston Gear Works, 64 Hayward St., Quincy 71, Mass.

RATIOMOTORS

The complete power package. Gear unit has fin-cooling and other high efficiency features of new 100 Series Reductors.

FLANGED REDUCTORS

The Ratiomotor gear unit, supplied without motor. You buy and attach any standard end-mounted motor of your own choice.

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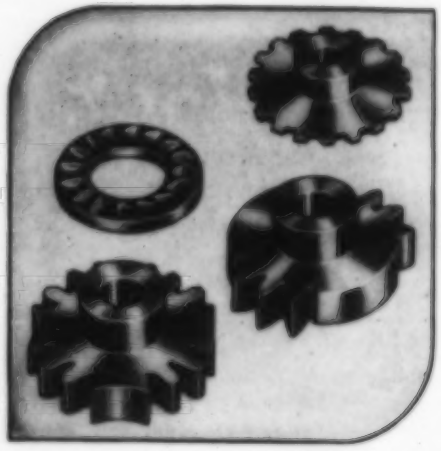

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Stress Relief

(*Continued from Page 307*)

friends' wives looked on him with less than enthusiasm. His everyday conversation was well splattered with figures of speech, picturesque but ribald, and his clothes, work day or dress, were equally picturesque. With no wife to convince him otherwise, he immediately saw the advantage of the celluloid collar for its convenience and low upkeep.

Called in by the big boss in a local industry that was having a problem, he was never welcomed by the employees—that is, never on the first call or where his reputation had not preceded him. Coming in as an expert under the auspices of the boss was not an immediate recommendation. But his messy clothes, celluloid collar, high blucher type shoes, and steel-rimmed spectacles aroused their interest. When he worked with shop personnel, his standard procedure was to "borrow" a chew of tobacco. By the time he left their problem, solved or unsolved, he was a great guy, or a rascal, depending somewhat on his mood, or whether he had to point a blunt finger of blame at someone.

Boundary Bill had a number of surprises in his system. For instance, calling a coin for drinks provided one outlet for his mechanical ingenuity. He figured that his companions were better able to pay for his drinks than he was for theirs. To insure that this eminently correct situation would occur (assisting Providence, as it were), he carefully and illegally shaved down eight coins to half thickness. After soldering, he had a penny and a dime with "heads" on both sides, a nickel and a quarter with "tails" on both sides, and an assured freedom from thirst.

Bill built his own automobile. Although intrigued by the internal combustion engine, he figured that steam was here to stay for a long time. I recall seeing his first car, puffing along the roads, putting out considerable smoke and noise. It finally exploded, fortunately injuring no one. I think he was trying to establish the upper boundaries on boiler pressure.

—J. P. HENDERSON

"Amazing how little this **TORRINGTON NEEDLE BEARING** *costs!"*

Initial cost of the Torrington Needle Bearing is much less than that of any comparable anti-friction bearing. But economy in first cost is only the start of savings which accrue to users of the Needle Bearing.

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Ease of installation trims costs on the assembly line, too. Just a simple operation on an arbor press places the hardened outer shell of the Needle Bearing in the housing.

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For twenty years, our Engineering Department has helped designers and manufacturers throughout industry to adapt the unique advantages of the Needle Bearing to their products. Let us help you make the Needle Bearing "standard equipment" in yours.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File —or write direct for Catalog No. 55.

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- runs directly on hardened shafts
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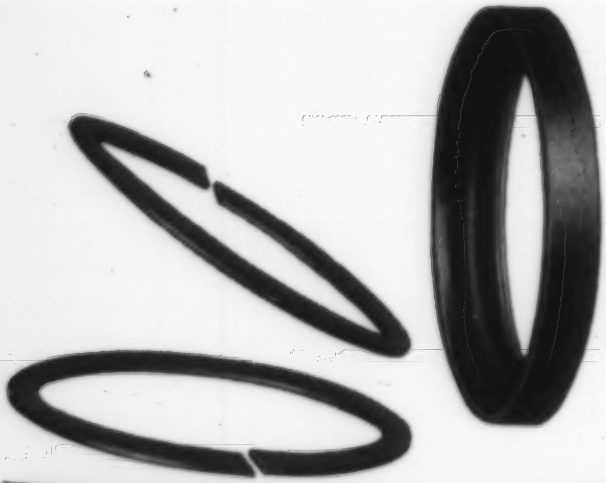

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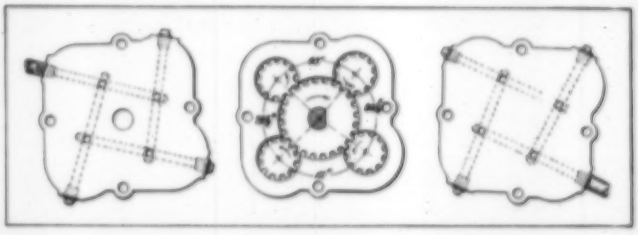
NOTEWORTHY Patents

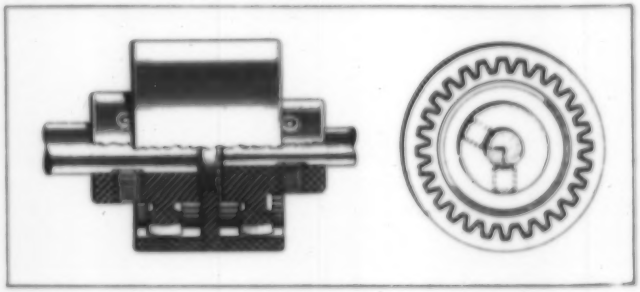
Nonpulsating Gear Pump

Multiple gear "impellers" in a fluid pump design minimize pressure surges in output flow. A single driving gear meshes with four pinion gears spaced at calculated unequal angles around the driving gear. Fluid is discharged into a common outlet system at out-of-phase intervals by each pinion gear. Combining the output of the four ports in this manner acts to smooth out the individual pulsations and provides a constant discharge flow. The same effect can be obtained by employing four or more pinion gears, with unequal numbers of teeth, spaced equally around the driving gear. *Patent 2,699,122 assigned to General Motors Corp. by A. F. Erickson.*



Plastic Shaft Coupling

A nonmetallic coupling for rotating shafts consists of a cylindrical sleeve with internal gear teeth and two collars or hubs with external teeth. Torque is transmitted from one hub to the other by the cylindrical sleeve which forms a positive connection through engagement of the mating toothed surfaces. Made of molded nylon or Teflon, the coupling members minimize operating weight and noise. *Patent 2,699,656 assigned to John Waldron Corp. by H. A. Anderson, R. Eadie and H. L. Morley.*



Constant Torque Drive Mechanism

Uniform tension may be maintained in winding tape, film, wire or ribbon with a reel drive mechan-

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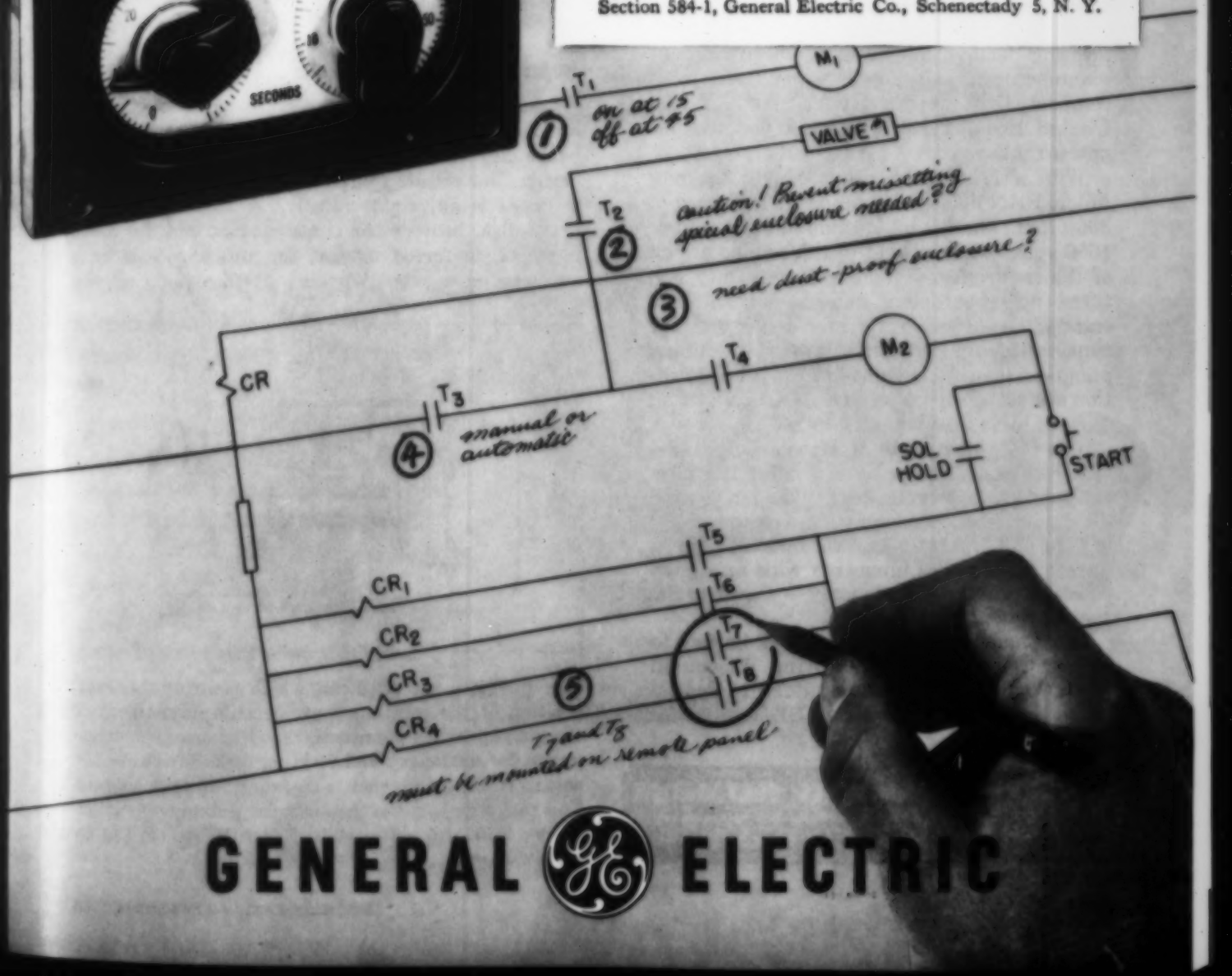
General Electric's new TSA-18 timer will reduce your industrial timing costs by eliminating the need for additional expensive features in your timing equipment. The extreme versatility offered by this new timer enables it to meet, with precise and dependable operation, the majority of your timing-equipment requirements.

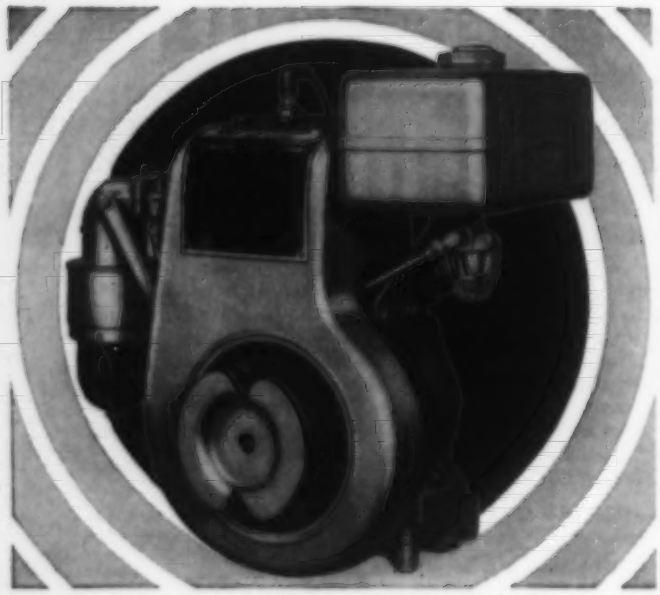
Here are a few of the outstanding features of the new TSA-18 which will meet your specific timing application requirements at no extra cost:

1. **DELAYED ON AND OFF TIMING** in time intervals from 1 second to 30 hours is available within the several hundred TSA-18 models.
2. **TO PREVENT MISSETTING,** each TSA-18 timer is equipped with a knob locking device.
3. **DUSTPROOF ENCLOSURE**—standard equipment on all TSA-18 timers.
4. **MANUAL AND AUTOMATIC CONTROL**—standard on all units—is available to you at no extra cost.
5. **FOR MULTIPLE CIRCUIT CONTROL** the TSA-18 can be cascaded without interfering with the proper location of the timing controls.

For more information call your nearest General Electric Apparatus Sales Office, or write for Bulletin GEC-1223 to Section 584-1, General Electric Co., Schenectady 5, N. Y.



GENERAL ELECTRIC



Another NEW

WISCONSIN Heavy-Duty *Air-Cooled* ENGINE

The Model BKN Single Cylinder 3.2 to 6.8 hp.

Brand new in design, this engine meets the increasing demand among original equipment manufacturers and engine power users for a compact, light weight, HEAVY-DUTY Air-Cooled Engine that offers a broad, flexible power range.

With a 17.8 cu. in. displacement, the new Model BKN delivers 6.8 hp. at its top speed of 3600 rpm., and 3.2 hp. at a minimum speed of 1600 rpm. Incorporated in this engine are all of the traditional Wisconsin Heavy-Duty features, including tapered roller bearings at *both* ends of the crankshaft; high tension rotary type *outside* magneto with Impulse Coupling; pump-circulated, constant-level splash lubrication system and efficient AIR-COOLING at all temperatures from sub-zero to 140° F.

The Wisconsin line of Heavy-Duty Air-Cooled Engines comprises a total of 12 different models, in 4-cycle single cylinder, 2- and 4-cylinder sizes, encompassing a power range of 2.3 to 36 hp. Here is power selectivity to fit your equipment requirements with maximum power advantage and economy — *Power to Fit the Machine and the Job.*

Our Engineering Department will be glad to co-operate with you in adapting Wisconsin power components to your equipment. For detailed data on the new Model BKN, write for Bulletin S-183.

WISCONSIN MOTOR CORPORATION

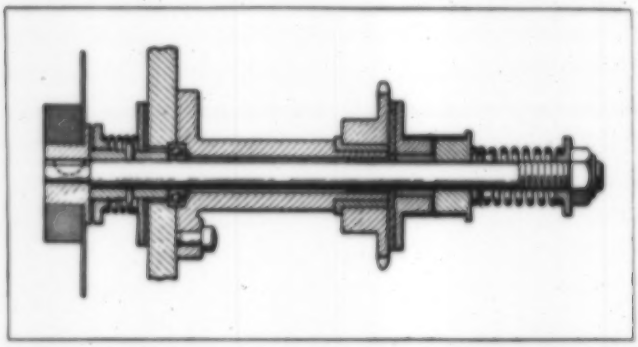
World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 8577-½VA

Noteworthy Patents

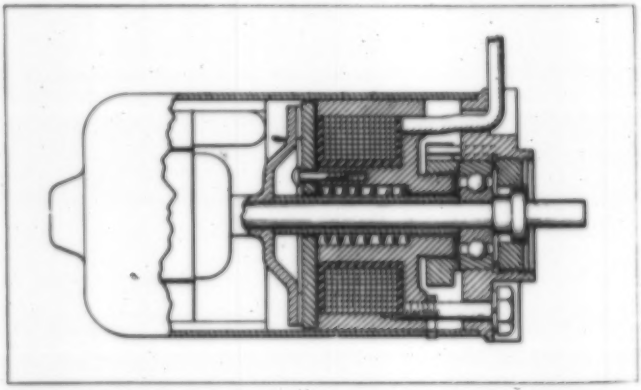
ism combining a one-way slip clutch with a friction brake. When winding, the reel is driven through a spiral spring wrapped around both a driving and driven drum. A felt friction pad in the drive system



allows slippage when the the reel is being overdriven. Drive reversal disengages the reel and permits it to unwind, subject to the braking action of the friction pad. In a complete drive system, two reel units are used with a common drive motor. In one direction of motor rotation, one reel acts as the supply unit and the other as a takeup. Reversing the motor automatically reverses the function of the two reels. *Patent* 2,705,599 *assigned to Houston-Fearless Corp. by J. D. McCollough.*

Adjustable Magnetic Brake

Load adjustment of an electromagnetic brake is accomplished by varying the air gap between the brake disk and the face of an electromagnet. In this design, the rotating shaft to which one brake disk is keyed is adjustable axially. A second stationary brake disk, between the electromagnet and the rotating disk, is forced against the rotating disk by a compression spring. Working against the compres-



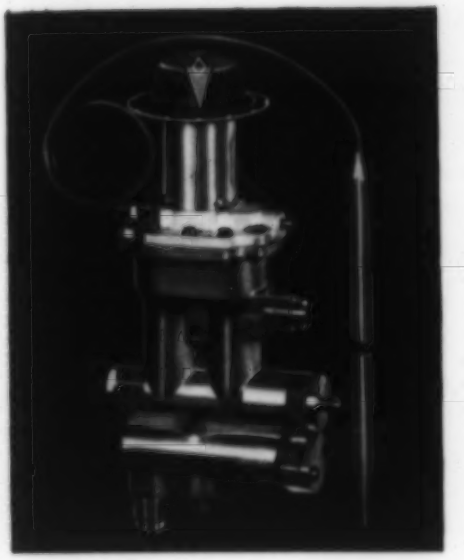
sion spring, a threaded nut which controls the axial position of the rotating shaft permits adjustment of the air gap. When energized, the electromagnet disengages the stationary and rotating disks to release the shaft. When the magnet is de-energized, the compression spring re-engages the disks for braking operation. *Patent* 2,701,036 *assigned to General Electric Co. by H. L. Osborne.*

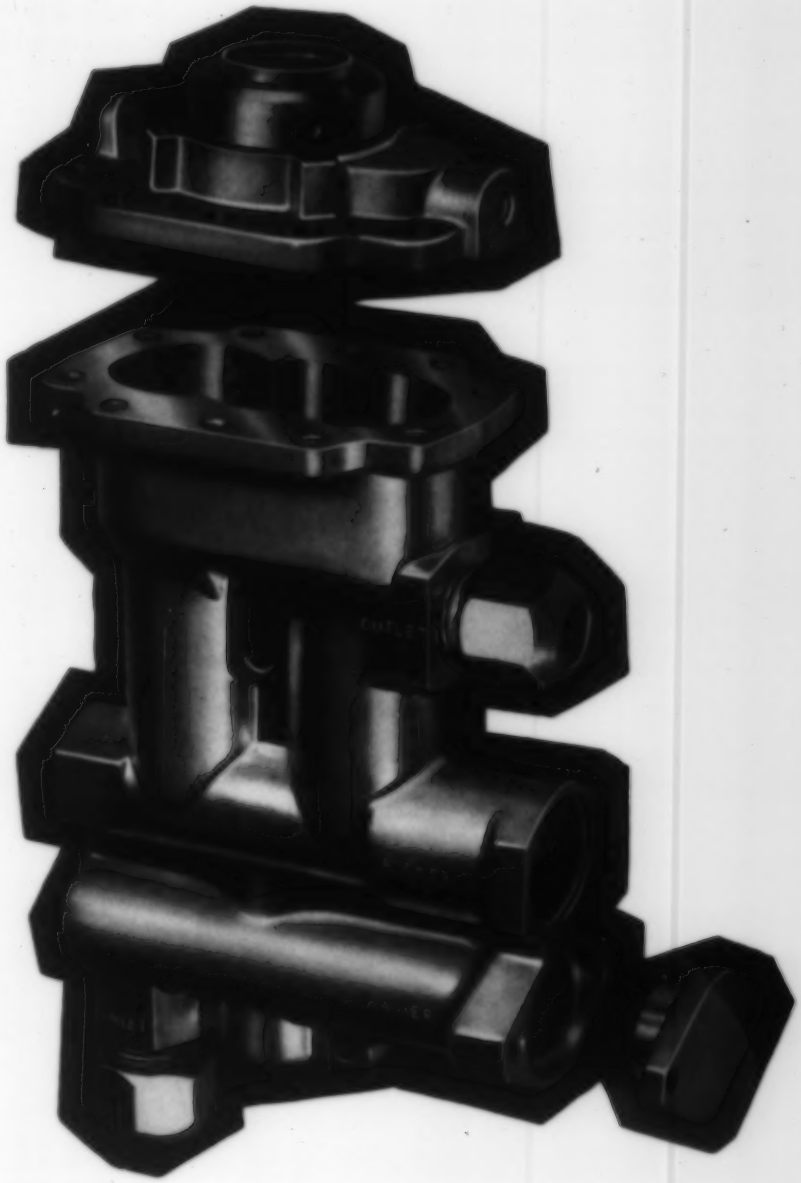
manufacture of

DETROIT SELECTAFLOW CONTROLS

greatly improved by

MUELLER BRASS CO. FORGINGS





One of the finest thermostat control mechanisms for year-around air-conditioning systems is the automatic SELECTAFLOW, a product of the Detroit Controls Corporation. To maintain the high quality of this efficient unit and at the same time speed up and simplify assembly, the body, bonnet and side cover are being forged and completely machined to close tolerances by the Mueller Brass Co. In all, thirty-four machining and finishing operations are performed. This is but one more example of how Mueller Brass Co. machined forgings have improved a product and speeded production. With a wide range of copper-base alloys for forgings, a tremendous background of product engineering, and facilities for precision finish machining, the Mueller Brass Co. can supply machined brass or bronze forgings to *your exact specifications*. It will pay you to consider Mueller Brass Co. forgings for your new or redesigned products. Write us for full color catalog and technical information.

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MUELLER BRASS CO.

PORT HURON 15, MICHIGAN

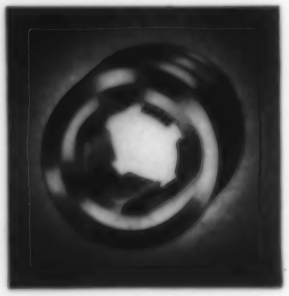
WHAT'S NEW AT BRISTOL...

Automation and Bristol Through-Broached Screws cut assembly time at Burroughs

BURROUGHS, DETROIT, reports that Bristol patented Through-Broached Socket Screws, hopper-fed to a power screwdriver, cut in half the time required to insert set screws in critical stop dogs for their Sensimatic Accounting Machine.

THAT'S NOT ALL. Machine-fed Bristol screws not only eliminate a tedious hand operation, but also cut loss of screws due to dropping and cross threading.

HOPPER-FEED is no problem with the double-ended, symmetrical Bristol Through-Broached Socket Set screw. It has all the holding power of a standard socket set screw but, to facilitate machine assembly, the socket is broached all the way through so it can be inserted from either end.



Write to The Bristol Company, Socket Screw Division. A.5.5

LARGE AND SMALL—WE MAKE THEM ALL

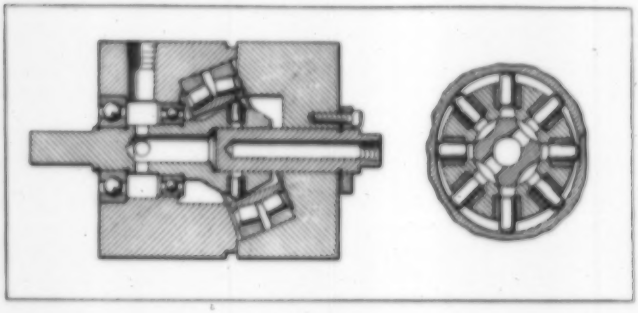
Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

Noteworthy Patents

Radial Piston Pump

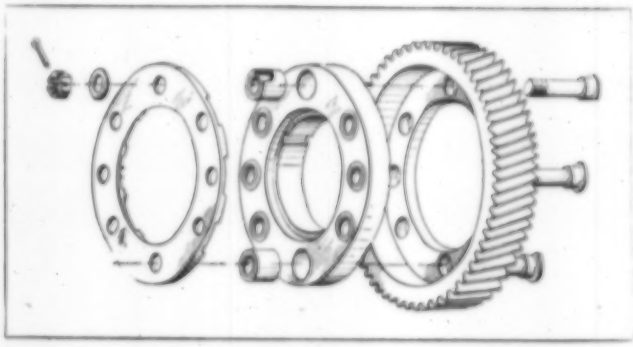
High-speed rotary hydraulic pump, using short-stroke radial pistons, provides two strokes per piston for each revolution of the rotor. Piston stroke is controlled by adjusting the angular position of the bearing in which the rotor is mounted. This "tilting" of the bearing acts to form an elliptical cam path



against which the pistons ride. As the rotor turns, cam action produces two strokes of each piston per revolution. Grooves in the pintle on which the rotor is mounted provide intake and discharge passages. The pump may be modified to provide adjustable control of the rate of output or to permit reversal of flow. *Patent 2,703,054 assigned to American Steel Foundries by J. N. Heater.*

Shock-Resistant Gearing

Starting shock or sudden impact loads in gear drive systems are absorbed by rubber bushings designed to transmit power between the teeth and hub of a gear assembly. Pins, around which the rubber bushings are fitted, are fixed to the outer toothed



member of the gear assembly. Holes in the hub member accommodate the resilient bushings to permit assembly of the toothed member. Each bushing is enclosed in a sleeve to prevent extrusion of the rubber under shock loads, thus eliminating the possibility of vibration due to rebound of the resilient elements. *Patent 2,702,995 assigned to Goodman Mfg. Co. by A. R. Biedess.*

Copies of the patents briefed in this department may be obtained for 25 cents each from The Commissioner of Patents, Washington 25, D. C.

Steam or Air Pumps

Centrifugal Pumps

Air Line Oilers

Single-Stage Compressors

Two-Stage Compressors

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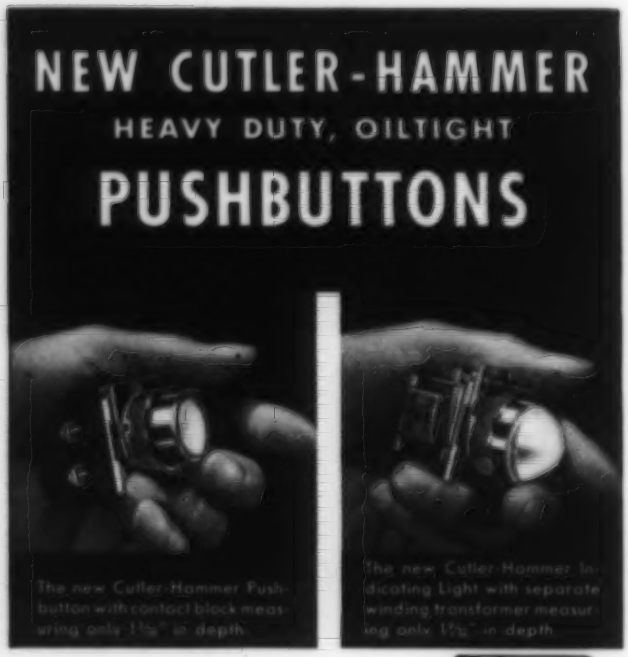

NEW CUTLER-HAMMER
HEAVY DUTY, OILTIGHT
PUSHBUTTONS
The new Cutler-Hammer Pushbutton with contact block measuring only 1½" in depth
The new Cutler-Hammer Indicating Light with separate winding transformer measuring only 1½" in depth

New small size contact blocks. New circuit flexibility. Better design; better performance; better appearance.

New small size contact block with both electrically and mechanically isolated contacts.

There is nothing to compare with Cutler-Hammer's new line of heavy duty oiltight pushbuttons, selector switches and indicating lights. There is nothing to compare with the new small size contact block which measures only 1½" in depth behind the mounting panel. Nor is there anything to compare with the greater degree of circuit flexibility this new contact block provides. Only *this* has contacts "in parallel," electrically isolated from one another so that you can apply a different voltage on each set, or alternating current on one and direct current on the other. There is nothing to compare in size or design with the indicating light, resistor or transformer type; nothing to compare in visibility with the new Cutler-Hammer indicating light.

So it goes throughout the complete new line. Every type of operator; every type of pushbutton; full range of colors in pushbuttons and indicating lights; new chrome-plated operators for lasting beauty; new design diaphragm for lasting performance. These and many, many other features are described in a new, fully illustrated bulletin. Write for it now. See the complete line at your authorized Cutler-Hammer distributor. CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

New Machines

Materials Handling

Lift Trucks: KGA 51 line of industrial lift trucks features fully automatic torque transmission. Large oil reservoir eliminates possibility of transmission overheating. Trucks have oil-cooled, oversize, hydraulically operated clutches, dual brake pedals and inching control. Oil pressure is provided by externally mounted pump equipped with relief valve. Transmission units are removable without disassembly; clutch disks can be replaced without removing major components. Models have capacities from 3000 to 8000 lb. *Yale & Towne Mfg. Co., Materials Handling Div., Philadelphia, Pa.*

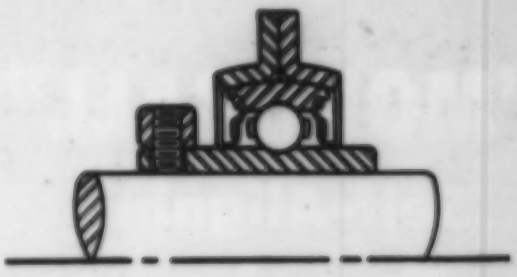
Straddle Carrier: Series 81 Pivoted Hook Carrier has load hooks which pivot inward to permit carrying without bolsters. Pivoting and vertical movement are controlled hydraulically. Permanent skids are required only on pick-up or delivery. Carrier has capacity of 20,000 lb, road speeds up to 40 mph, four-wheel steering, and four-speed synchromesh transmission. Centrally located driver's seat affords 360-deg visibilty. Hook mechanism is mounted in vertical roller slides having antifriction bearings; hooks are mounted in bronze bushings. Trucks are available in six models for loads ranging in height from 48 to 66 in. and in widths from 40 to 52 in. *Clark Equipment Co., Ross Carrier Div., Benton Harbor, Mich.*

Die Handler: Model 1014 die handler handles dies or molds measuring up to 36 by 75 in. and weighing up to 6000 lb. Top platen, driven by a 2-hp electric motor mounted in base, rises 12 in. per minute. Power for rotational movement is supplied by ¾-hp motor. Two hand cranks allow fine adjustments in positioning and rotational movement. *Hansford Mfg. Corp., Rochester, N. Y.*

Metalworking

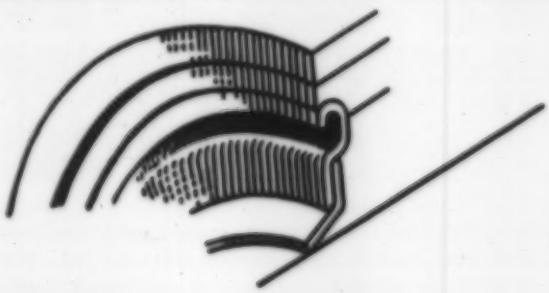
Engine Lathe: Axelson 32-in. engine lathe for extremely heavy hogging cuts has 75 hp capacity. Horsepower indicator permits selection of feeds and speeds to utilize maximum output of the motor. Two-lever shift facilitates changing of spindle speeds. Standard foot-mounted, clutchless motor drives the headstock gearing through V-belts. Starting and stopping of heavy inertia loads is accomplished by electrical plugging. For load requirements under 75 hp, a clutch is provided. Spindle speeds vary from 6 to 750 rpm. All headstock gears are splash lubricated; gearbox is totally enclosed and provides a selection of 81 feeds. Full range of threads from 1 to 30 threads per inch may be produced. Selection of threads or feeds is provided by a single lever and dial positioner in the gearbox. New taper attachment

LOW COST is achieved with the use of an especially sturdy, pressed steel housing that combines strength and light weight, yet equipped with the same high quality precision bearing used in all Link-Belt ball bearing blocks.



UNRESTRICTED SELF-ALIGNMENT. Aligning surface of housing is precision-coined to assure proper fit and support of bearing. Free-rolling action and full load capacity are maintained even with shaft misalignment.

It's important
bearing differences
like these that add up to strength plus economy



MAXIMUM SEALING EFFICIENCY. Synthetic rubber lip-type seal, integral with the bearing, retains lubricant and excludes dirt . . . even in extremely dusty conditions. Greased at factory, bearing needs no further lubrication.

SINGLE-ROW, DEEP GROOVE BALL BEARING assures smooth operation and long life. Manufactured in accordance with the standards for the Anti-Friction Bearing Manufacturers Association BCO2 ball bearings.

They're all present only in this new, low-cost LINK-BELT ball bearing

HERE'S the kind of specialization you get in industry's most complete line of ball and roller bearing blocks. The wide-spread need for a low-cost bearing—offering precision, anti-friction bearing performance—led to development of the JPS-200. Bulk is minimized—unrestricted alignment and effective sealing characteristic of Link-Belt bearings are maintained. The result is a bearing that costs you less . . . yet can challenge any for efficiency in light-duty applications.

Every Link-Belt bearing is made to meet just such a specific need. Ask your Link-Belt office for Folder 2517 on the JPS series. Get Book 2550 for data on Link-Belt's complete line.

Low-cost series JPS-200 is part of industry's most complete line of ball and roller bearing blocks.

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LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,713

"MONOBALL" Self-Aligning Bearings

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CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Moly Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Address Dept. MD55.

SOUTHWEST PRODUCTS CO.
DUARTE, CALIFORNIA

New Machines

embodies a large, close-coupled swivel block equipped with take-up gibs; maximum travel is 30 in., maximum taper is 7 in./ft or 16 deg. Lathe has built-in oil reservoir and one-piece tailstock. Heavy-duty spindle is available with standard Morse tapers. *U. S. Industries Inc., Axelson Mfg. Co. Div., Los Angeles, Calif.*

Milling Machine: Model 16S ram type miller has adjustable cutter head which permits horizontal, angular and vertical milling, plus boring and drilling without attachments. Adjustable cutter head has 4-in. quill travel. Eight spindle speeds range from 110 to 3600 rpm. Cutterhead spindle motor is rated 2 hp. Other specifications are: table size, 40½ in. x 10 in.; power table travel, 22 in.; hand cross feed, 10 in., hand vertical feed, 22 in.; ram movement in and out over column, 20½ in. *Van Norman Co., Springfield, Mass.*

Drilling and Boring Machine: For drilling, reaming, boring, tapping and spot facing operations with cutting tools, model 3045 horizontal drilling and boring machine has a 5-in. diameter Nitralloy spindle providing 42 in. of continuous spindle travel under power feed. A positive drive employs motors up to 25 hp. Accurate tool location is provided throughout the travel range by a two-speed traverse mechanism, controlled from a pushbutton, which gives rapid traverse at 100 in. per minute and positioning traverse at 4 in. per minute. *Kaukauna Machine Corp., Kaukauna, Wis.*

Press Brakes: Four new series of press brakes have steel welded frame, deep-section bed and ram of rolled steel plate to provide permanent alignment and minimum deflection under load. Double-end drive from the intermediate shaft provides even application of pressure over the length of the ram for accurate bending. One-piece main gear and eccentric at each end rotate on hardened alloy-steel shafts. All gears are enclosed. Friction clutch and band brake are provided on flywheel shaft. Clutch can be jogged or slipped to meet operating conditions. Split ram design permits adjustments for tapered work. Capacity range of the four models is from 48-in., 10 gage stock to 144-in., 14 gage stock. Drive motors of 1½, 3 and 5 hp are available. *Dreis & Krump Mfg. Co., Chicago, Ill.*

Slotting Machine: Model 5 screw head slotter slots standard or special-headed, ferrous or nonferrous blanks varying in size from No. 6 to ¼-in. diam, and up to 2½ in. long. Production speeds are variable from 60 to 864 blanks per minute. Ease of setup combined with high-speed operation make the machine suitable for both long and short runs. *Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.*

Plant Equipment

Snow Thrower: Jari Champion rotary type snow thrower can clear a path 20 in. wide through any depth or type of snow at the rate of 520 shovelfuls per minute. A raker bar, consisting of six flat steel teeth mounted on the whirling fan, cuts up heavily packed

snow into small pieces which are thrown to one side by the fan. Machine is self-propelled and is powered by a 2½-hp, 4-cycle gasoline engine. Thrown snow is spread over a 30-ft strip to prevent large banks. Angle of throw is adjustable. Thrower has two forward speeds, independent clutch, spark plug cover to guard against short circuits, and 16-in. solid rubber wheels. *Jari Products Inc., Minneapolis, Minn.*

Lubricating Unit: Aro Prime Mobile Lubricating unit is designed for use in industrial plants, mining operations, airports and other installations where power lubrication is required. Powered by a 6-hp air-cooled engine, the unit has a maximum travel speed of just under 4 mph. It can turn in a 33-in. radius. Air pressure is provided by a single-stage air compressor. The machine is equipped with three heavy-duty hose reels and 25 ft of hose. It carries three 120-lb drums of lubricant. *Aro Equipment Corp., Bryan, Ohio.*

Processing

Barrel Finisher: Space-Miser is a one-unit barrel finisher requiring floor space of 40 by 26 in. Barrel is 20 in. long, 14 in. diam, and is mounted on sealed, self-aligning ball-bearing pillow blocks. One or two-compartment barrels are available, with compartment capacities of 1.9 and 0.95-cu ft, respectively. Adjustable-speed motor is 1/3-hp, 110 v, single-phase. A sump-settling drawer has three equal settling compartments and drain outlet. Cabinet, pans and drawer are of heavy gage steel. Overall height of the unit is 48 in; work level height is 34 in. *Speed-D-Burr Corp., Glendale, Calif.*

Degreaser: Model PW1000 automatic degreaser is designed for production cleaning of articles ranging from small parts to large dies. Working platform measures 60 by 45 in. and moves up and down through cleaning compound at a rate of 38 strokes per minute. Load capacity is 1000 lb. Machine can be employed as a cold solvent cleaner and is also available in units heated by gas, electricity or steam for use with detergents and water. Heating apparatus is mounted in a removable door. Tank is constructed of 3/16-in. steel plate. Motor is 3 hp. *Kleer-Flo Co., New York, N. Y.*

Rotary Tablet Press: Model 533 rotary tablet machine can handle a variety of industrial compacting operations such as ceramics, powder metals and plastics preforming. Production ratings range to 2500 tablets per minute. Roll pressure rate is 36,000 lb per inch of displacement. Neckless punches are standard equipment. All controls, including tachometers and pressure indicators, are grouped on the front of the press. Changes in tabletting procedure can be made while the machine is running. The press is lubricated automatically. Two machines are available: One has 33 stations, makes tablets up to 1 1/16 in. diam, 1⅛ in. depth of fill at rate of 900 to 2500 per minute; the other has 27 stations, makes tablets up to 1 3/16 in. diam, 1⅜ in. depth of fill at rate of 700 to 2000 per minute. *F. J. Stokes Machine Co., Philadelphia, Pa.*

NOW FOR AUTOMATIC CONTROL EQUIPMENT

WESTON
Speed-Change SENSING System

- ACCURACY . . . within ¼ of 1% maximum speed
- OPERATING SPEED . . . continuously variable up to 80,000 rpm
- LOW INITIAL COST

For precision control equipment, Weston now provides this accurate and flexible sensing unit, with continuous speed indications, at new low cost. Employing the simple and proved Weston frequency responsive system, operation is virtually maintenance free. For complete information, including block diagram and prices, ask your nearest Weston representative, or return the coupon below.

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Newark 5, New Jersey

Please send literature on your Speed-Change Sensing System.

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Company _____

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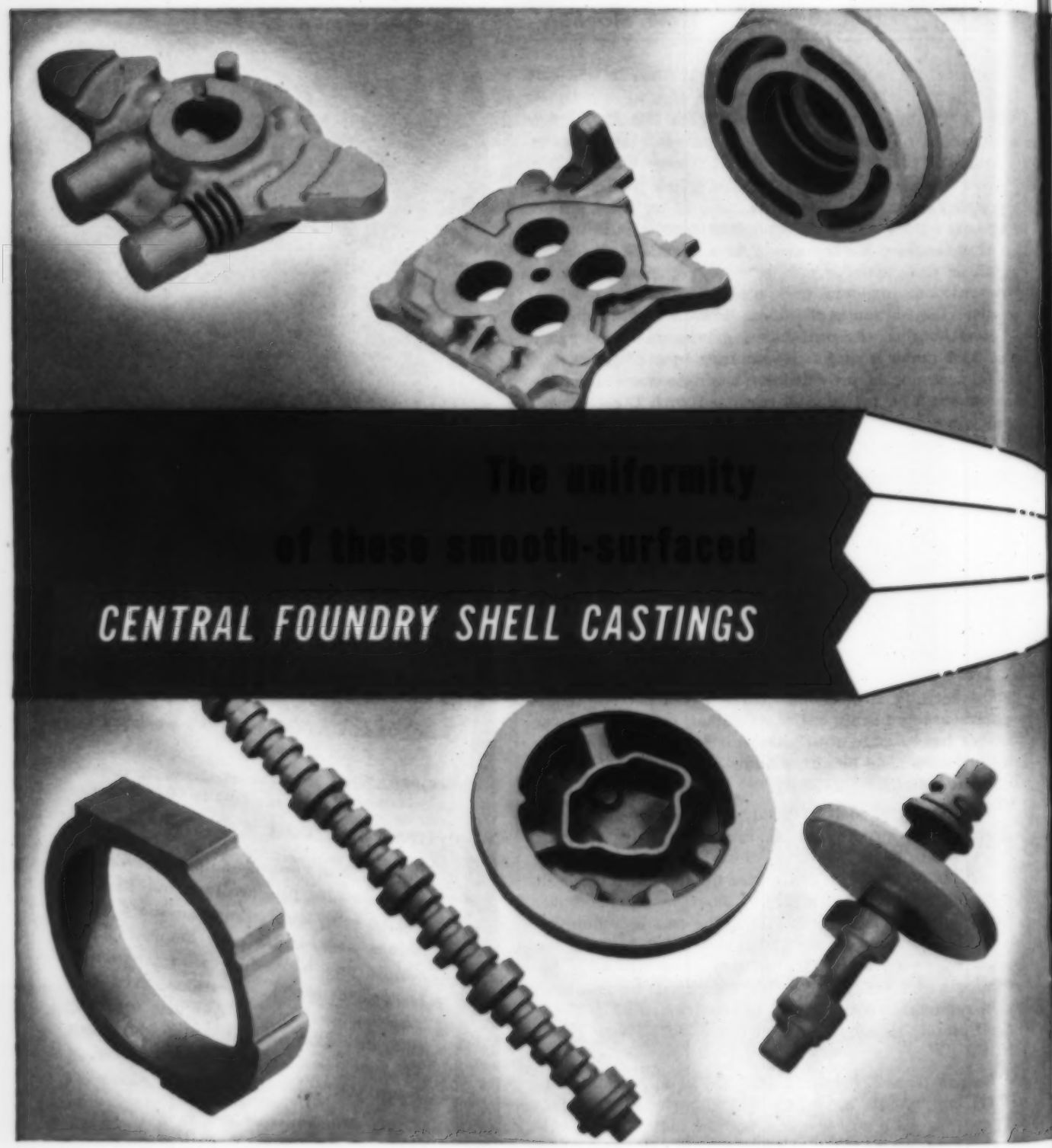

In shell casting, the mold is formed by a thin shell of sand bonded by a thermo-setting plastic. This shell has a hard, smooth surface as accurate as the pattern itself. Shell casting has many advantages • complicated cast contours (impossible with the green sand process) are practical • uniformity with reduced finish allowances permits lower machining cost and longer tool life • improved casting surfaces, free from residual sand, often eliminate machining on non-functional areas and • lower casting weights effect savings in freight charges.

For further information about shell casting grey iron, malleable iron or Armasteel and how it may improve or effect economies in your product, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

makes it possible to greatly

reduce machine cycle time

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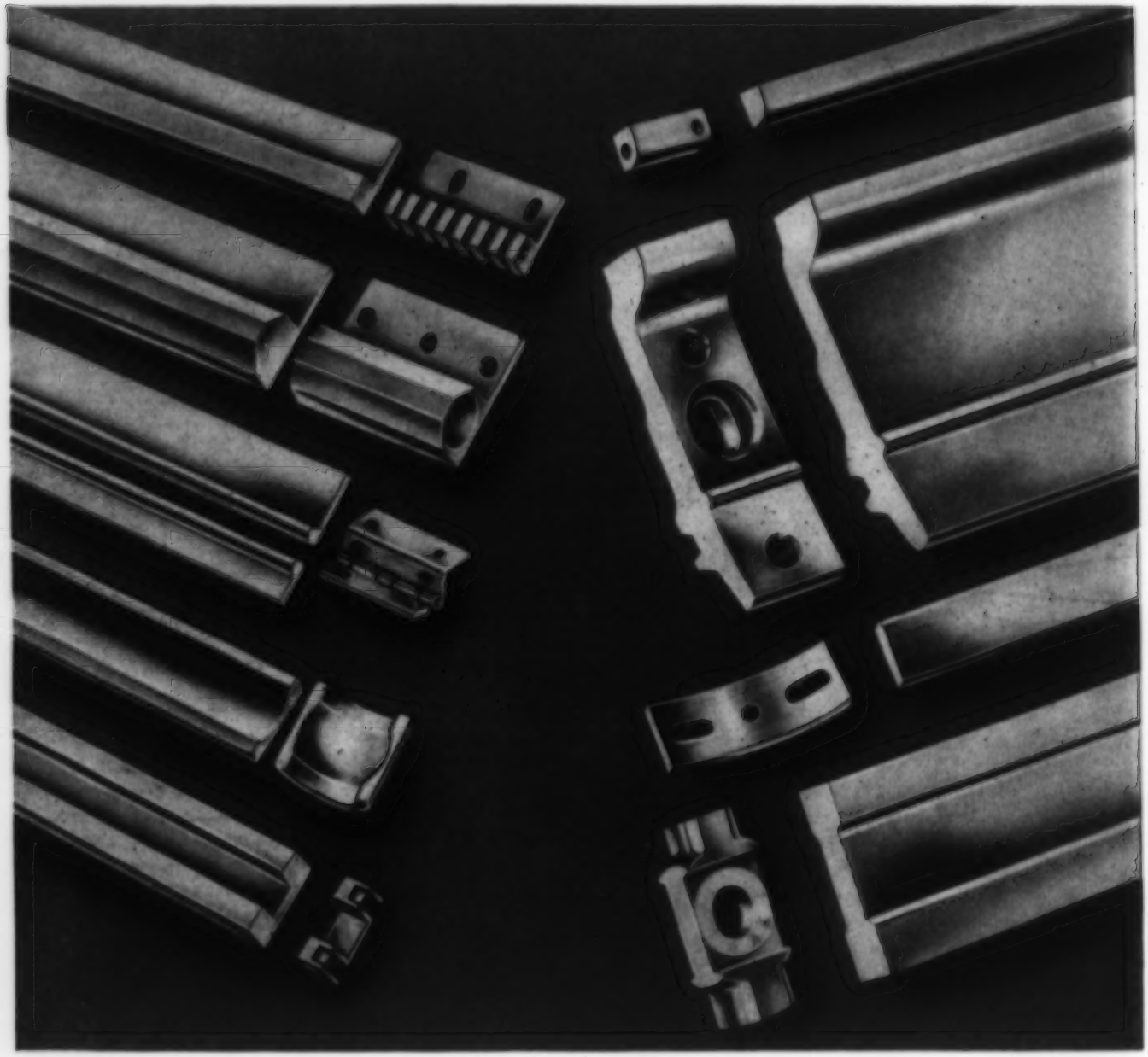

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get a superior wrought metal product with Anaconda extruded shapes

Cost-paring possibilities unlimited: In few areas can imagination and ingenuity pay off so handsomely as when applied to the use of extruded shapes. Visualize your finished parts as cross-sectional pieces cut from a long extruded shape.

Costs come down, quality goes up: Extruded metal is *wrought* metal—tough, dense-grained, smooth-surfaced, and easy to machine. When you switch from cast parts, you eliminate rejects due to pits and porosity; you reduce machining, scrap . . . and finishing time.

A manufacturer of hosiery knitting machines, for example, found he saved from 25-30% over cast brass. He makes 420 components from 12 different ANACONDA Extruded and Drawn Brass Shapes. He also gets the superior precision, balance, and long-wearing and bearing qualities in these parts, which must operate at high speeds.

Metals: Extruded shapes are available in copper, brass, bronze, and special copper alloys—in long mill lengths suitable for feeding into turret lathes or automatic screw machines.

Our experience at your service: The American Brass Company pioneered in extruded shapes. The accumulated experience of the organization, its wide selection of dies, may help you short-cut production and save money.

We'll be glad to make suggestions based on your sketch or sample. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®
EXTRUDED SHAPES

MACHINE DESIGN

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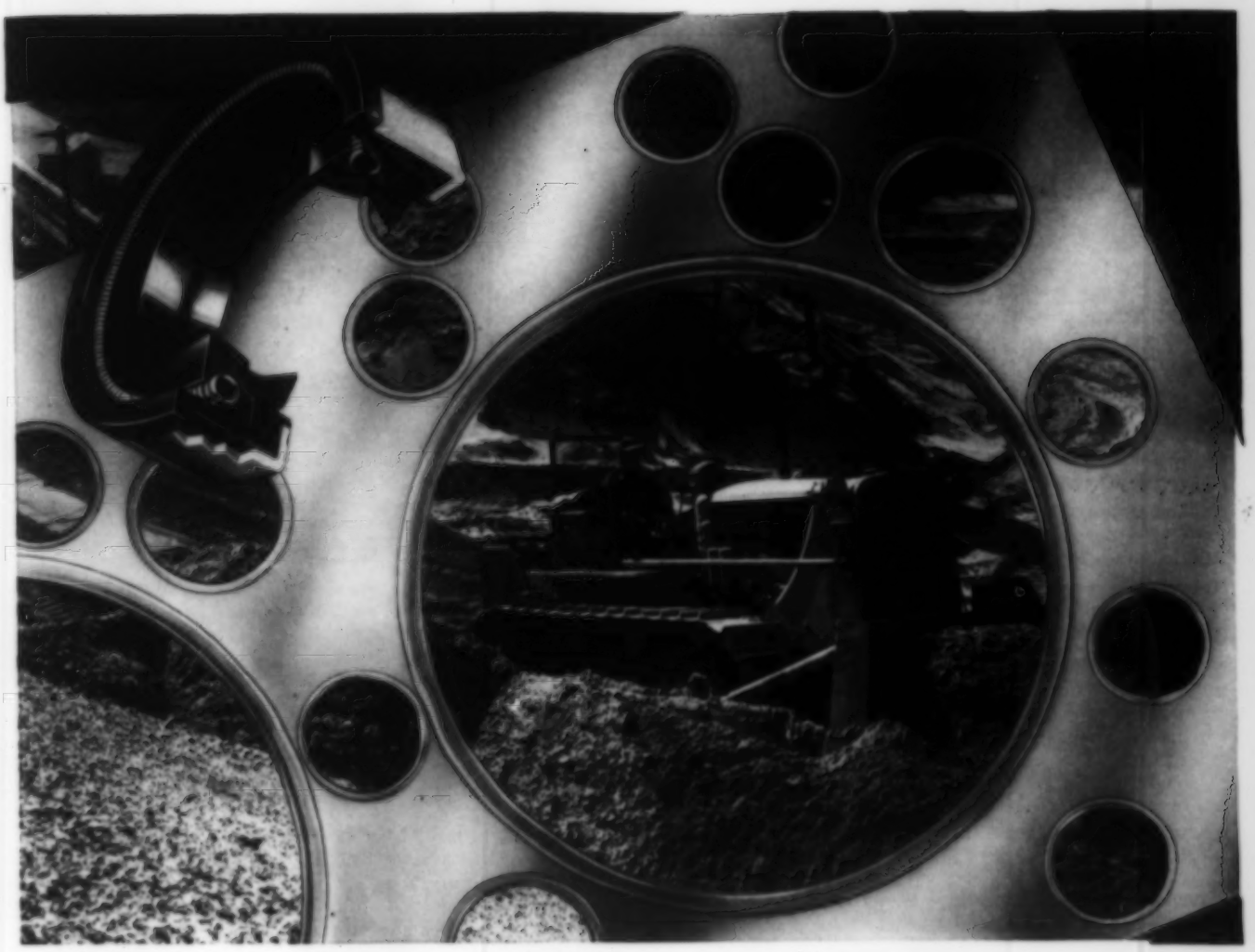

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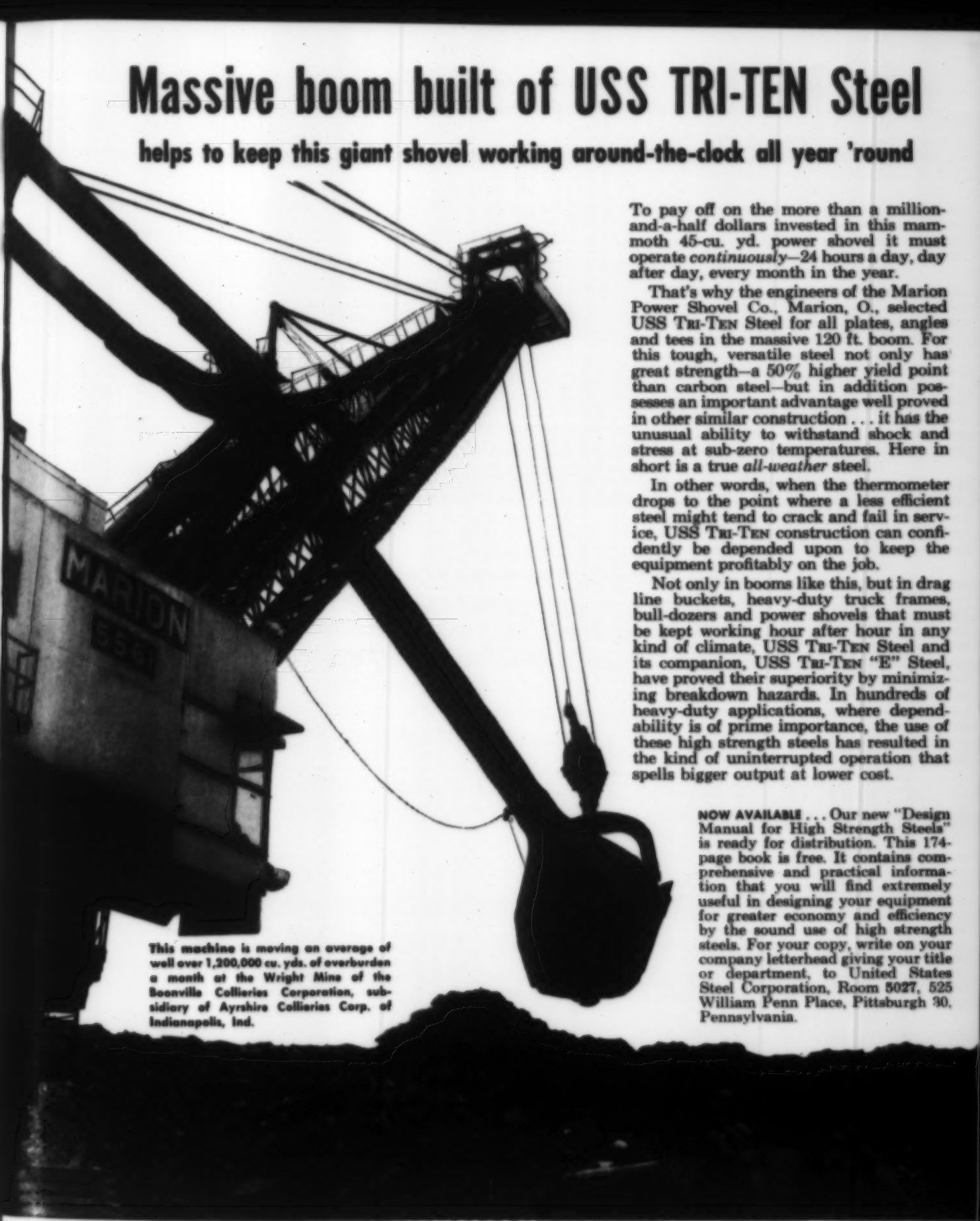

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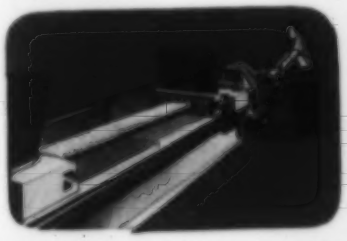

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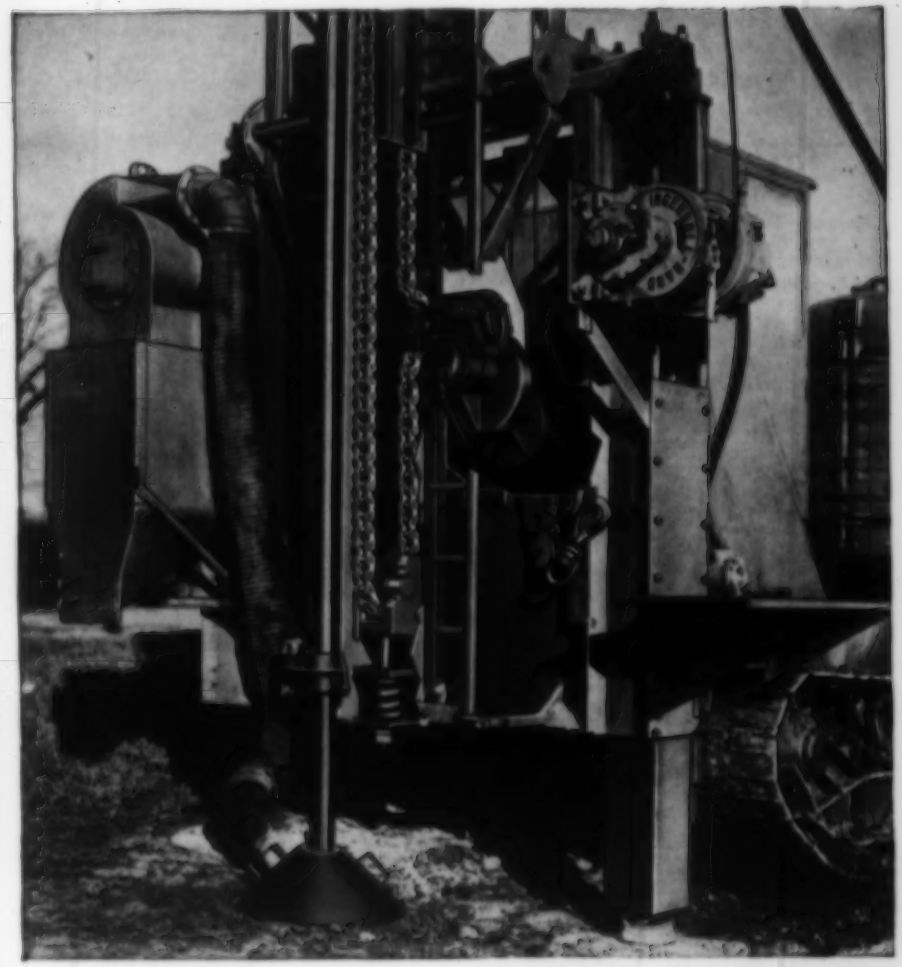

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Heart of the trouble on one type of clutch was its air tube. Inflation or deflation of this tube actuated the clutch by engaging or disengaging the opposing friction plates. But the oil and constant flexing resulted in tube failure. Finally, the G.T.M.—Goodyear Technical Man—was consulted.

The G.T.M., in cooperation with the rig manufacturer, changed the design, the rubber compound and the molding technique. The result was a tube which, on one particular rig where previous service averaged two to five months, has served 20 months and is still going strong. Laboratory tests of this new tube show an expected life of over ten years.

How can the G.T.M. improve your product? All molded goods problems find better solutions at Goodyear, Industrial Products Division, St. Marys, Ohio or Akron 16, Ohio.

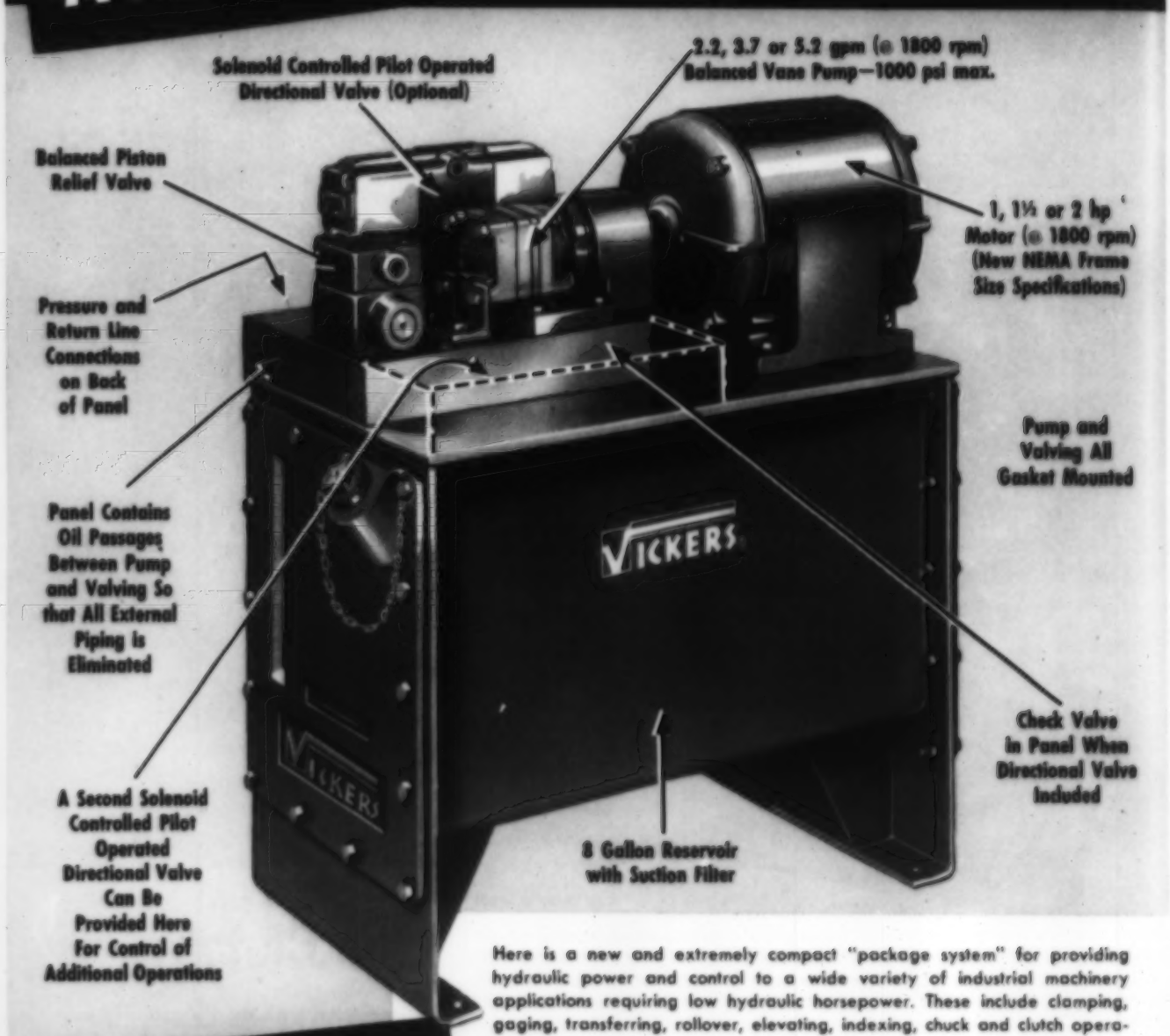
MOLDED GOODS by

GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like "THE GREATEST STORY EVER TOLD"—every Sunday—ABC Radio Network—THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

A NEW IDEA . . . in hydraulic power and control systems


Solenoid Controlled Pilot Operated Directional Valve (Optional)
2.2, 3.7 or 5.2 gpm (@ 1800 rpm) Balanced Vane Pump—1000 psi max.
Balanced Piston Relief Valve
1, 1½ or 2 hp Motor (@ 1800 rpm) (New NEMA Frame Size Specifications)
Pressure and Return Line Connections on Back of Panel
Pump and Valving All Gasket Mounted
Panel Contains Oil Passages Between Pump and Valving So that All External Piping is Eliminated
VICKERS
Check Valve in Panel When Directional Valve Included
A Second Solenoid Controlled Pilot Operated Directional Valve Can Be Provided Here For Control of Additional Operations
8 Gallon Reservoir with Suction Filter

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Series T8

HYDRAULIC PIPELESS POWER PACKAGE

7311

Here is a new and extremely compact "package system" for providing hydraulic power and control to a wide variety of industrial machinery applications requiring low hydraulic horsepower. These include clamping, gaging, transferring, rollover, elevating, indexing, chuck and clutch operations, etc.

Note the many features indicated on the photograph above. The result is improved and simplified hydraulic design . . . also reduced installation and maintenance costs. This "package system" has great flexibility . . . is available in a wide variety of combinations of standard components assembled to suit individual requirements. Pretested and ready for immediate operation, it has also the advantage of undivided Vickers responsibility. For further information, ask for installation drawings 178706-8.

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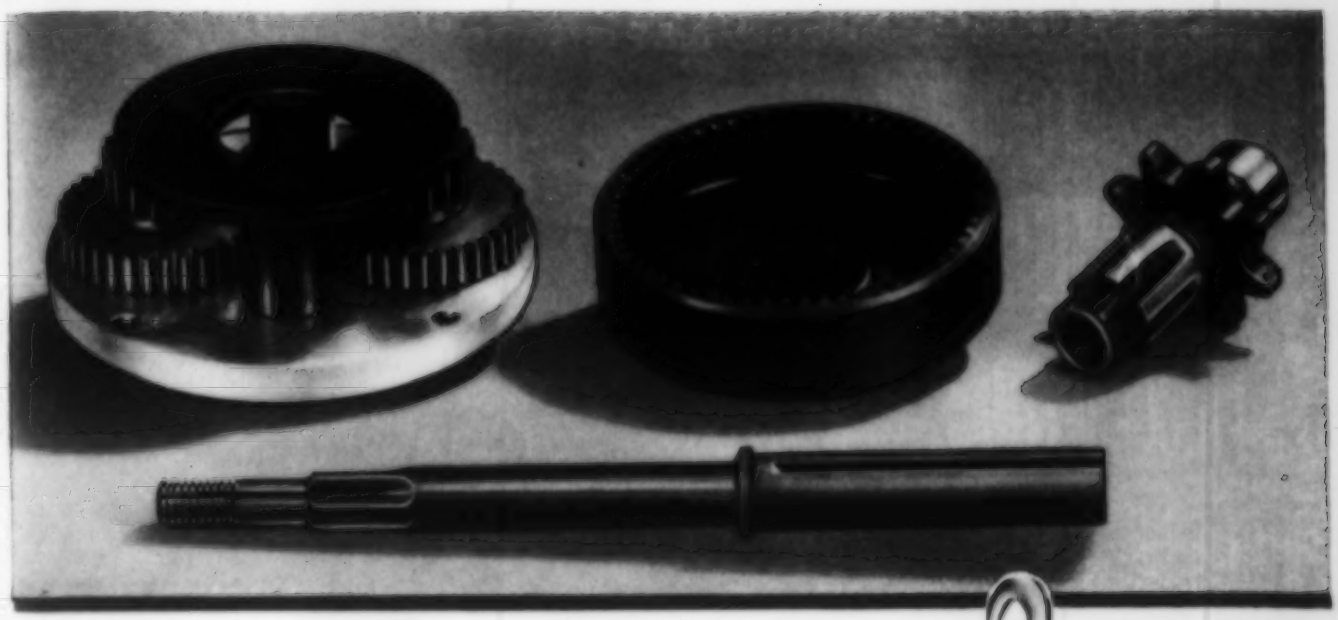
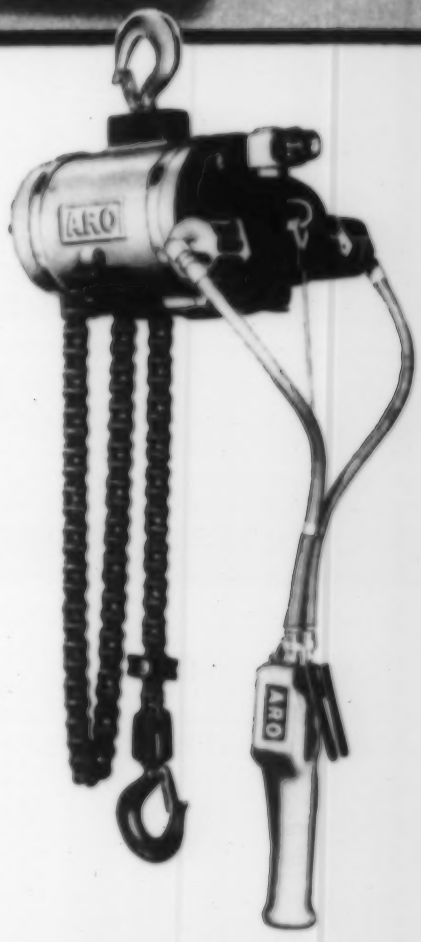
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

*These "package systems" supplement the Vickers line of standard hydraulic power units.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



G. S. GEARING GIVES THE ACCURACY NEEDED FOR THE RUGGED ARO HOIST



GEARING by G. S. measures up to the most exacting specifications for the ARO Lever Pendent Control Hoist, pictured here. Made in production runs, the *quality* of this fine G. S. Gearing is so uniform that assembly headaches are unknown. And, the smooth, dependable performance of this sturdy ARO Hoist is assured.

If you manufacture a product in which Small Gearing is involved, by all means tell US about your needs. Let our experienced engineers suggest or design the best and most economical Gearing for the job! You pay nothing for this valuable service. It may improve your product and cut costs, too! Will you send along drawings and details today?

SEND FOR.. our 6-page Small Gearing Guide. It describes 80 types and applications. Contains useful charts . . a valuable aid to anyone interested in Small Gearing. Use company letterhead, please. No obligation, of course. Write today!

40 Years of Specializing in Small Gearing!

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WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Good, Strong Gears Begin with Good, Strong Blanks

Because strength is usually the first requirement in a gear, Bethlehem devotes unusual care to the making of gear blanks. And equally important, Bethlehem has developed a process of manufacture that assures high strength *without* excessive weight.

This process is unique; there is nothing else like it. First, a heated round is placed in a special mill where it is upset, forged and rolled in a single operation. The resulting blank is dense, homogeneous, compact; the grain flow of the steel is smooth and uniform.

These characteristics go hand in hand with strength. Moreover, blanks made by this method are easy to machine, and fewer cuts are required in a good many cases.

When making gears—spur, bevel, miter, helical, and others—you can rely completely on Bethlehem blanks. But their use is not confined to gears alone. In fact, they're excellent for a long list of applications —crane wheels, industrial wheels, turbine rotors, clutch and brake drums, sheave wheels, flywheels, pipe flanges, tire molds, etc. The blanks are available in sizes from 10 to 42 in. OD, and can be furnished treated or untreated.

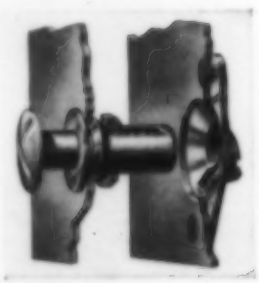
If you would like more complete information, write for a copy of Booklet 216. It will be sent to you promptly without cost or obligation.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

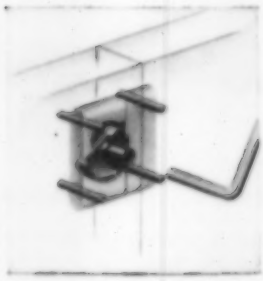
BETHLEHEM STEEL

3 ways to save on assembly costs



QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.

SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. Made in all-metal and plastic with steel insert. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.



ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals; recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36 PAGE CATALOG WITH APPLICATIONS
SEND FOR IT

Simmons Fasteners are widely used in refrigerators, washing machines, electrical equipment, electronic assemblies, prefabricated portable shelters, coolers, demountable furniture. Every Simmons Fastener is a service-proved design with a long record of assembly-cost saving in many industries.

If you are interested in cutting your costs, turn to Simmons Fasteners—the fasteners with *uses unlimited*. Write for samples and catalogs today.

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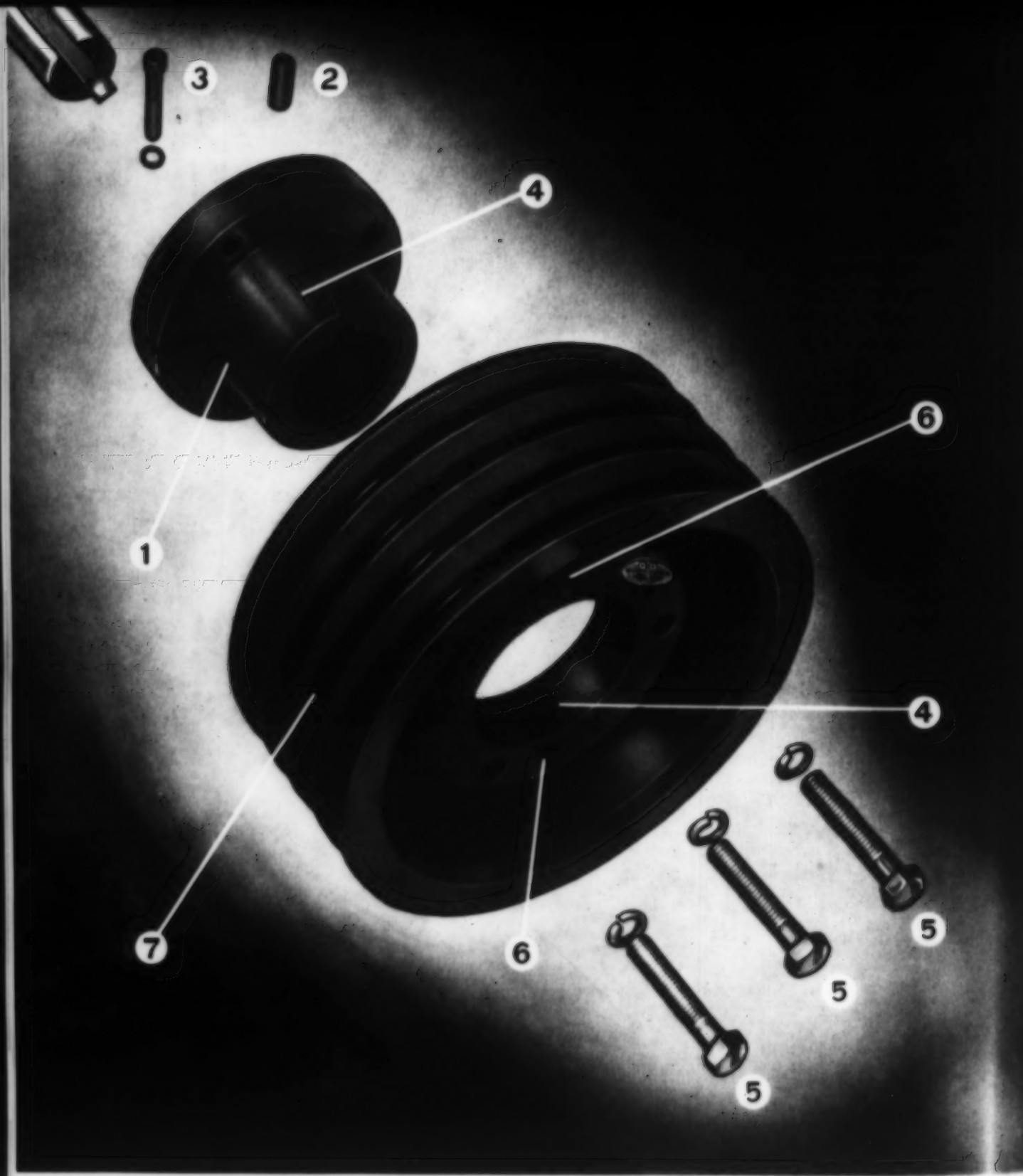


EXPLODED VIEW of Worthington QD Sheave shows design features that make it industry's first choice.

1. **COMPLETELY SPLIT QD HUB** holds shaft tightly under heaviest shock loads.
2. ***CUP POINT SET SCREW** in QD hub keeps shaft key in position.
3. ***CLAMP SCREW** secures hub in proper alignment on shaft when mounting sheaves.
4. **TAPERED FIT** between hub and sheave allows easy-on, easy-off, hold-tight action.
5. **PULL-UP BOLTS** draw sheave on to hub to produce positive fit on shaft.
6. **TAPPED HOLES** in sheave permit pull-up bolts to be used as jack screws to break cone grip when removing sheave.
7. **GROOVE CROSS-SECTIONS** are accurate and uniform so that each V-belt seats properly, pulls evenly.

***All Worthington-Manufactured QD Heavy-Duty Hubs incorporate these exclusive features.**

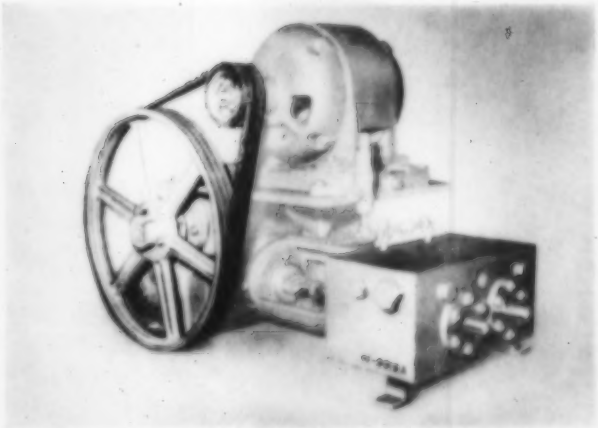
Who says all sheaves are alike?

Nobody who ever saw the Worthington QD, we wager.

Big difference between the QD (that's short for quick-detachable) and ordinary sheaves is this: the QD is easiest to get on, easiest to get off, yet always grips tightly on the shaft.

Those are the big reasons why design engineers specify more QD's than any other sheave — why the QD will do a *better* job on *your* product.

More reasons for standardizing on the QD

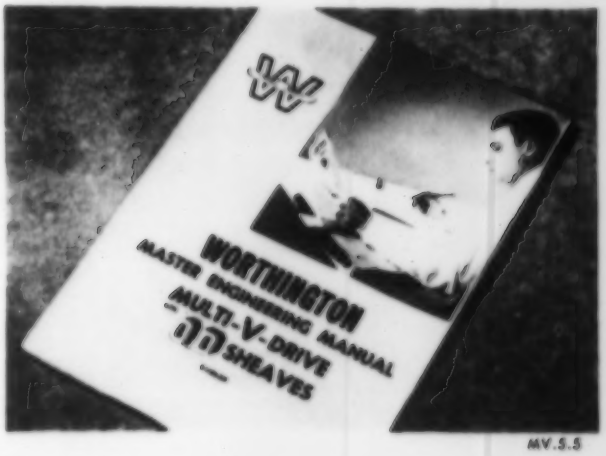


SCIENTIFIC DESIGN of Worthington QD Sheaves not only provides more efficient transmission of power but actually adds to the looks of your product. What's more, I-beam construction of the QD DriveN sheave provides greater strength with less weight. You'll find Worthington QD Sheaves a dependable source of trouble-free mechanical power transmission. The large variety of immediately available standard sizes and ratings, for A, B, C, and D section V-belts, makes for a simple, economical solution to your design problem.

PROMPT SHIPPING SERVICE. Thirteen factory warehouses with stocks covering over 100,000 V-belt drive combinations, from ½ to 600 horsepower, support more than 250 distributor outlets. These shipping centers can fill your requirements *fast*.

Warehouses Located at: Kearny, N. J. • Oil City, Pa. • Portland • San Francisco • Los Angeles • Denver • Tulsa • Ft. Worth • Houston • New Orleans • Chicago • Cleveland • Atlanta, Ga.

GOOD NEWS FOR DESIGN ENGINEERS! Now, with Worthington's new 100-page "Master Engineering Manual," you can select the right sheave and V-belt combination for your equipment in *three minutes*. Easy-to-use tables take all the complications out of sheave selection — require only simple arithmetic. Be sure to write for your copy today. It's free, of course. Worthington Corporation, Mechanical Power Transmission Division, Section MV.5.5, Oil City, Pa.



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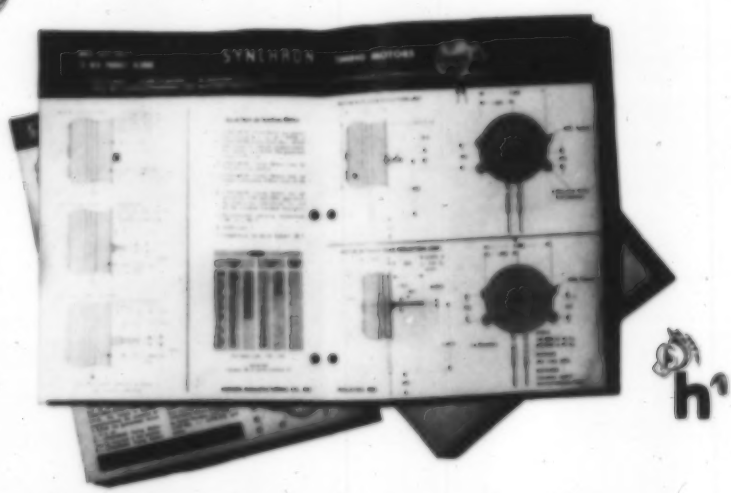
SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

exploratory planning . . .



can often mean tremendous savings in production

SUCCESS OR FAILURE of your new product or timing device may well depend upon cost of production. It may be sound in principle and design . . . may meet a specific need . . . but if it costs too much to make, out the window it goes.

Often a slight change in motor application or gearing will enable you to trim manufacturing costs to a practical and profitable figure. It is here that Synchron engineers can help materially. Just tell us what is expected of our motors* . . . the general nature of the job the mechanism is to do, performance characteristics, and the proposed method of mounting. Send along a sketch if possible.

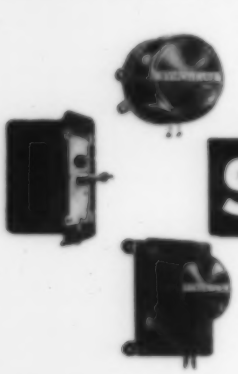
Our engineers will submit their suggestions and a sample motor . . . assistance which may save you many costly hours of research and testing. This service is strictly confidential, and available without obligation to established, rated organizations.

Get in touch with your SYNCHRON representative or write direct to the factory. You will receive prompt, efficient and courteous attention.

FACTORY REPRESENTATIVES:

Wesley & Fromm, 5254 W. Madison St., Chicago, Ill.
R. H. Winslow & Associates, 123 E. 37th St., New York, N. Y.
Electric Motor Engineering, Inc., 8255 Beverly Blvd., Los Angeles, Cal.
Cable-Hight Co., 1900 Euclid Ave., Cleveland 15, Ohio
Lawrence Sales Co., P. O. Box 13026, Dallas, Texas

*SYNCHRON synchronous motors operate smoothly and quietly in any position, at temperatures from —40° to +140° F. . . . start instantly under load . . . pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.



"Workhorse of the Industry"

SYNCHRON SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, AND MAGNA-TORC D.C. MOTORS

HANSEN MANUFACTURING CO., INC. PRINCETON 12, INDIANA

Established 1907

FACT:

The new Life-Line A is the most weather-resistant motor on the market

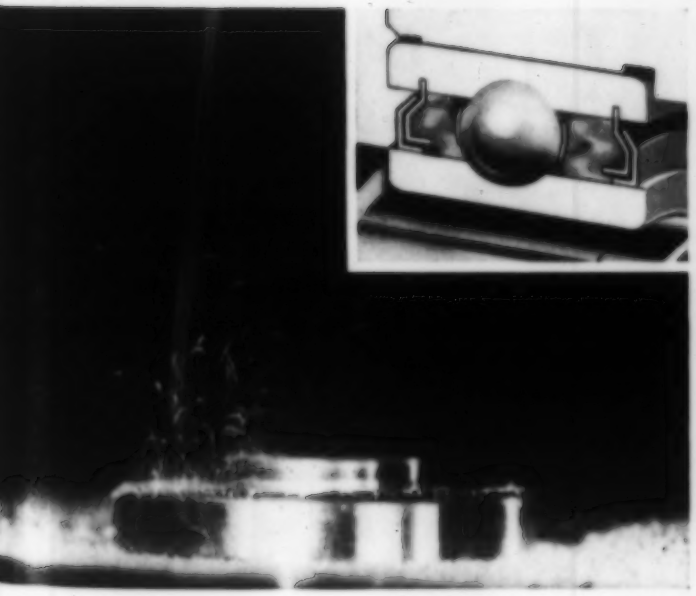
Whether your application is hot—cold—wet or dry, you'll find the new Westinghouse Life-Line® "A" motor will last longer under more extreme weather conditions than any other motor you can buy.

New insulation materials, housing designs, 4-way sealed bearings are tangible evidence of electrical, mechanical and lubrication system improvements that make Life-Line "A" industry's most preferred package of power.

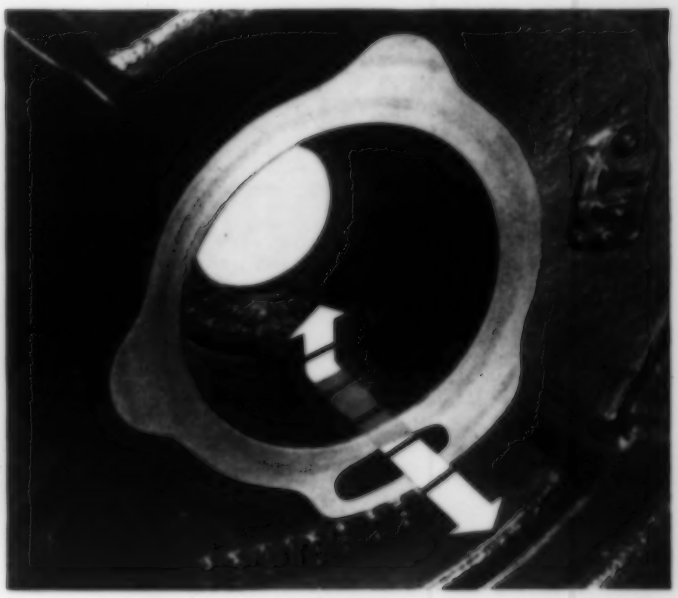
Get all the facts by calling your Westinghouse sales engineer . . .
The Man With The Facts.

J-21882

YOU CAN BE SURE...IF IT'S
Westinghouse

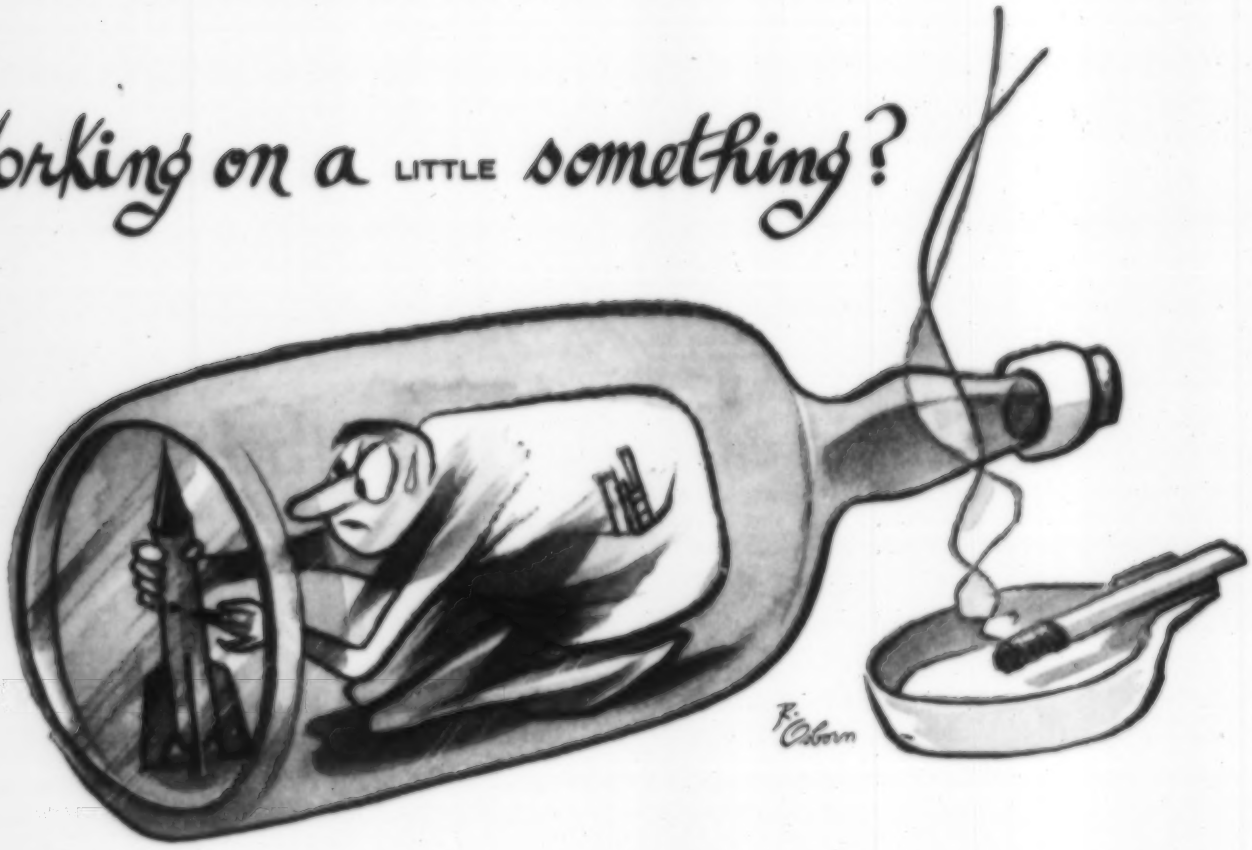


Lubrication System Fact—Two outer seals of new 4-way sealed bearing act as flingers and literally (see photo above) throw off damaging contaminations. Inner seals, attached to outer bearing race, are stationary and form a positive labyrinth with outer seals.



Mechanical System Fact—New exclusive air by-pass on totally-enclosed motor permits the motor to breathe around the bearing—not through it—minimizing atmospheric damage. Finest grained castings used in new cast-iron housings.

Working on a LITTLE something?



Dont let problems of miniaturization be your bottleneck! Cut coupon for complete catalog describing over 500 types and sizes of MPB's* such as these

BALL BEARINGS ACTUAL SIZE

Miniature Precision Bearings, Inc., 3 Precision Park, Keene, N. H.

YES! Send me your complete new MPB CATALOG

name title company

street city zone state

*MINIATURE PRECISION BEARINGS, INC., KEENE, N. H.

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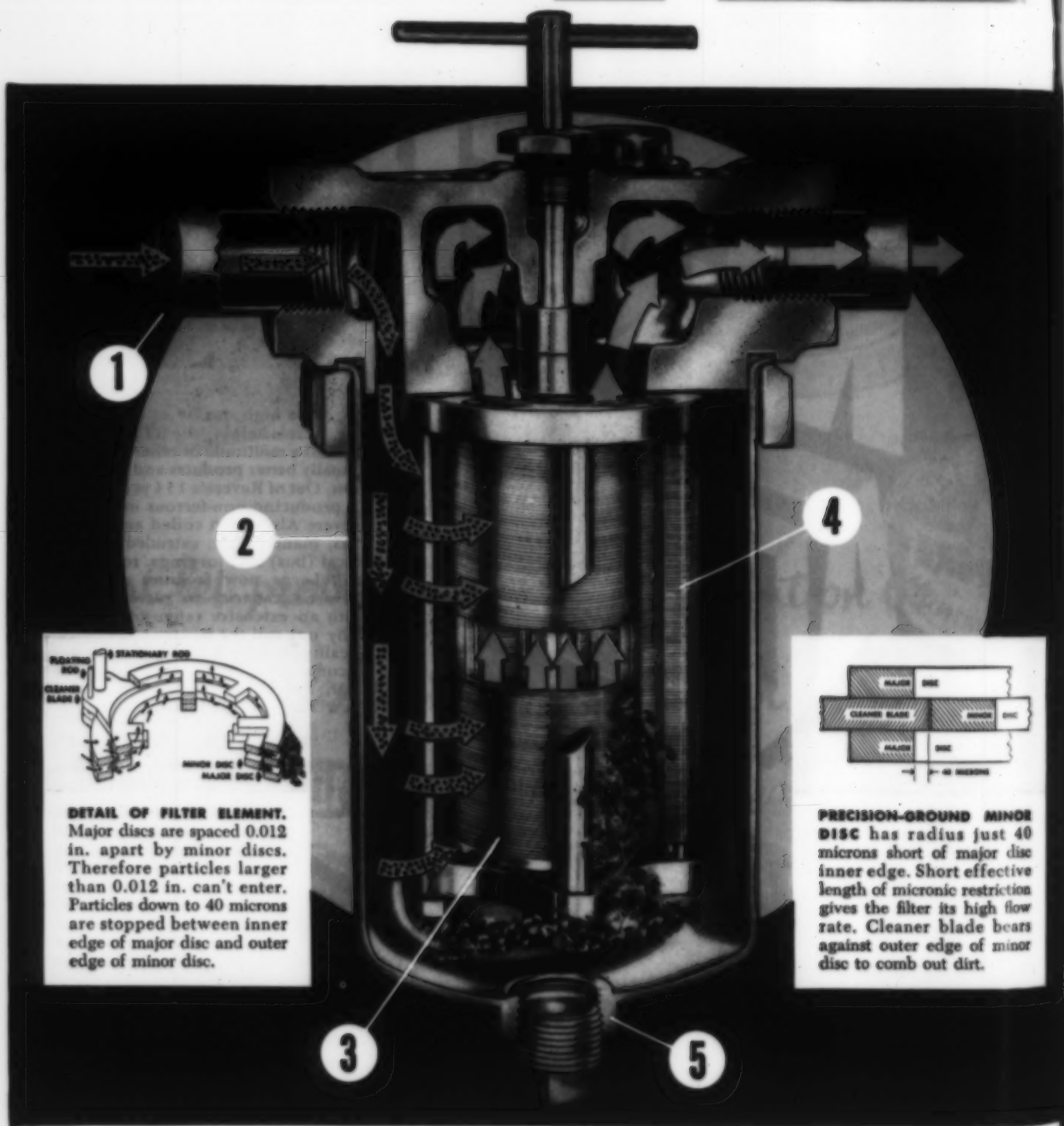
The high quality of Revere Aluminum Products is helping the transportation industry and a multitude of others to provide continually better products and services at lower cost. Out of Revere's 154 years of experience in producing non-ferrous metals have come Revere Aluminum coiled and flat sheet, circles, blanks, tube, extruded products, electrical (bus) bar, forgings, rolled shapes and foil. Large new facilities greatly increase Revere's capacity to serve you, especially with an extensive range of sheet products. Why not call the Revere sales office in your locality, today? Revere Copper and Brass Incorporated, *Founded by Paul Revere in 1801,* Executive Offices: 230 Park Avenue, New York 17, N. Y.
REVERE KNOWS ITS A-B-C's
ALUMINUM BRASS COPPER

New! CUNO 40-micron



DETAIL OF FILTER ELEMENT. Major discs are spaced 0.012 in. apart by minor discs. Therefore particles larger than 0.012 in. can't enter. Particles down to 40 microns are stopped between inner edge of major disc and outer edge of minor disc.

PRECISION-GROUND MINOR DISC has radius just 40 microns short of major disc inner edge. Short effective length of micronic restriction gives the filter its high flow rate. Cleaner blade bears against outer edge of minor disc to comb out dirt.

CUTAWAY of new SUPER Auto-Klean. Dirty liquid enters inlet (1) at left, fills housing (2) and flows through metal-edge filter (3) of stacked major and minor discs. Trapped dirt is combed out by cleaner blades (4) when discs are rotated and is removed through drain (5). Clean liquid rises through center of filter element, leaves at right.

self-cleaning filter!

The SUPER Auto-Klean for lube, hydraulic fluid, coolant, fuel and other liquids

. . . and you can clean this filter by simply turning the handle!

Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, compact, micronic filtration at high flow rates and eliminates the need for replacement cartridges. On machine tools and industrial machinery, SUPER Auto-Klean gives micronic filtration of lubricating oil, hydraulic fluids, coolants, fuels and other liquids. Here's what it offers:

1. Full-flow micronic filtering with a self-cleaning filter. Filter can be cleaned continuously with motor drive or intermittently by manually turning handle.

2. Eliminates cartridge changes. Ends operating costs if you've been using cartridge filters.

3. No pressure drop build-up. An 8-in. long, 2½-in. diameter cartridge handles 30 gpm of oil of 200 SSU viscosity with only 3 psi pressure drop—up to 75% more with slightly higher pressure drop.

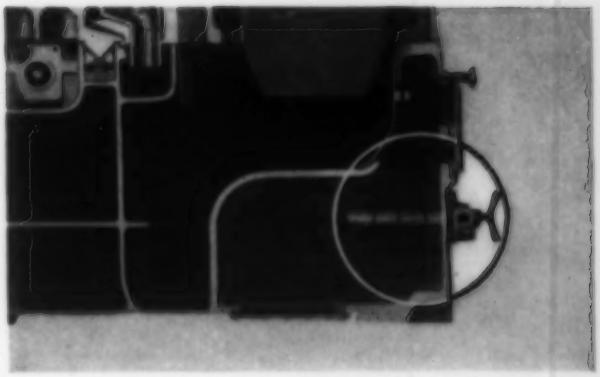
4. Positive protection against particles larger than 40 microns (actually 0.0015 in.). Filter can't rupture or channel.

5. Much smaller than replaceable-cartridge-type filters of equal capacity. It saves with lower initial costs, lower installation costs, requires less space than cartridge units. You get high capacity in a small package.

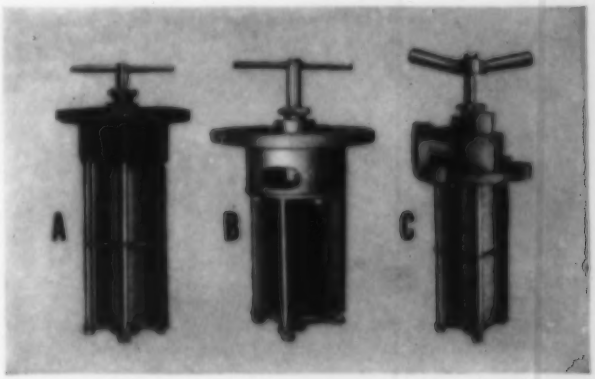
6. No duplex units needed. Handles full flow all the time with no interruptions for cleaning.

7. SUPER Auto-Klean fits existing Auto-Klean housings. You can easily replace most 2¾-in. diameter cartridges with SUPER Auto-Klean for finer filtration.

Send coupon for complete information on the new SUPER Auto-Klean filter, for your new designs or existing equipment. Cuno Engineering Corporation, 14-12 South Vine Street, Meriden, Conn. 56



WILL IT FIT? Here's how one designer answered that question. Filter *(circled)* mounts horizontally in side wall of hydraulic fluid reservoir in this surface grinder.



FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best in filtration. Flange mounting with external outlet *(C above)* and line-type *(cutaway on facing page)* are just two of many other possibilities.

MAIL COUPON FOR COMPLETE INFORMATION

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids from More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO-KLEAN (fibre cartridge)
FLO-KLEAN (wire-wound) • PORO-KLEAN (porous metal)

CUNO ENGINEERING CORPORATION
14-12 South Vine Street,
Meriden, Connecticut.

Please send me full data on the NEW Cuno SUPER Auto-Klean filter.

Name_____

Firm_____

Position_____

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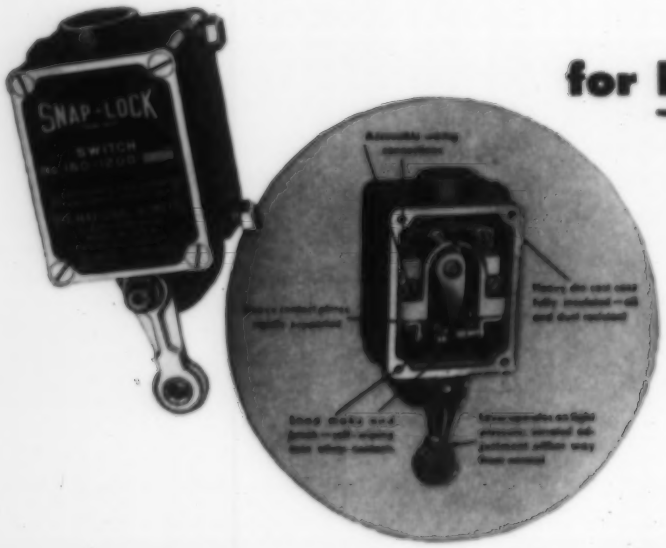
City_____ Zone_____ State_____

need limit switch help?

you'll find it in National Acme's Complete Line of Switches



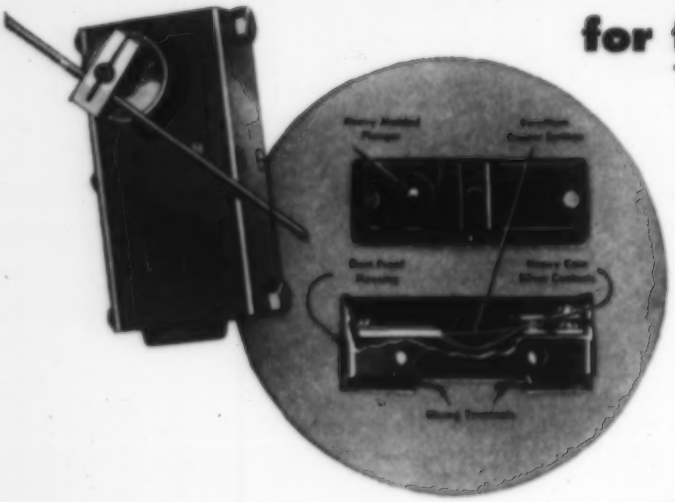
for heaviest-duty installations

SNAP-LOCK'S basic design simplicity and ruggedness have earned acceptance by the majority of manufacturers, including machine tool builders, as the standard for original equipment use.

- Positive locking in either position.
- Normally closed operation of either side.
- Use on AC or DC.
- Standard Models include short travel, neutral position, water resistant and hazardous location styles.
- Wide variety of operating lever and mounting styles.

(Left) Electrical side (completely sealed from mechanical operating side)

CATALOG EM-51 GIVES COMPLETE SPECIFICATIONS



for feather-touch applications

National Acme SUPER-SENSITIVE switches are especially suited for limit switch use—counting devices, safety switches, gauging devices, relays, liquid level and pressure controls—and countless other uses.

- Compact, durable, light contact.
- For AC line voltage use.
- Rotary, oscillating and plunger type models can be mounted in any position.
- Ordinary vibration will not interfere with operation.

(Left) Micro Switch in Namco protective housing.

ASK FOR CATALOG EM-50-S

Also of great importance to our customers is the vast specialized engineering experience available to them from National Acme . . . to help determine correct capacities, housings, space, type of mountings and to assist with special problems for the most practical application at lowest cost—of National Acme Limit Switches and "Stellite"-weld Solenoids.

May we assist you in designing these trouble-free switches into your equipment

ELECTRICAL MANUFACTURING DIVISION

THE NATIONAL ACME COMPANY

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Setting safer paths for little feet

3M ADHESIVES

America's school buses carry especially precious cargo. That's why their designers and manufacturers place great emphasis on all details pertaining to passenger safety. Safe, non-slip flooring is one of the essentials.

To anchor floor matting to the steel floors of their school buses—and to *keep* it anchored, smooth and "trip-free"—many bus manufacturers have standardized on a 3M rubber-based adhesive. They chose it for safer floors . . . *and* because they need fast application and a quick, strong, lasting bond that will stand up under vibration, temperature changes and strong cleaning solutions.

See what adhesives can do for you . . .

3M's rubber-based adhesives provide a swift, low-cost way of joining a variety of materials. Other 3M adhesives, coatings and sealers have been created to do very specific jobs in just about every industry you can name. Like to see some more examples of what other companies are doing with 3M products? Call in your nearest 3M Field Engineer. Or, for more detailed facts on 3M products serving industry today—write to 3M, Dept. 1912, 417 Piquette Avenue, Detroit 2, Mich.

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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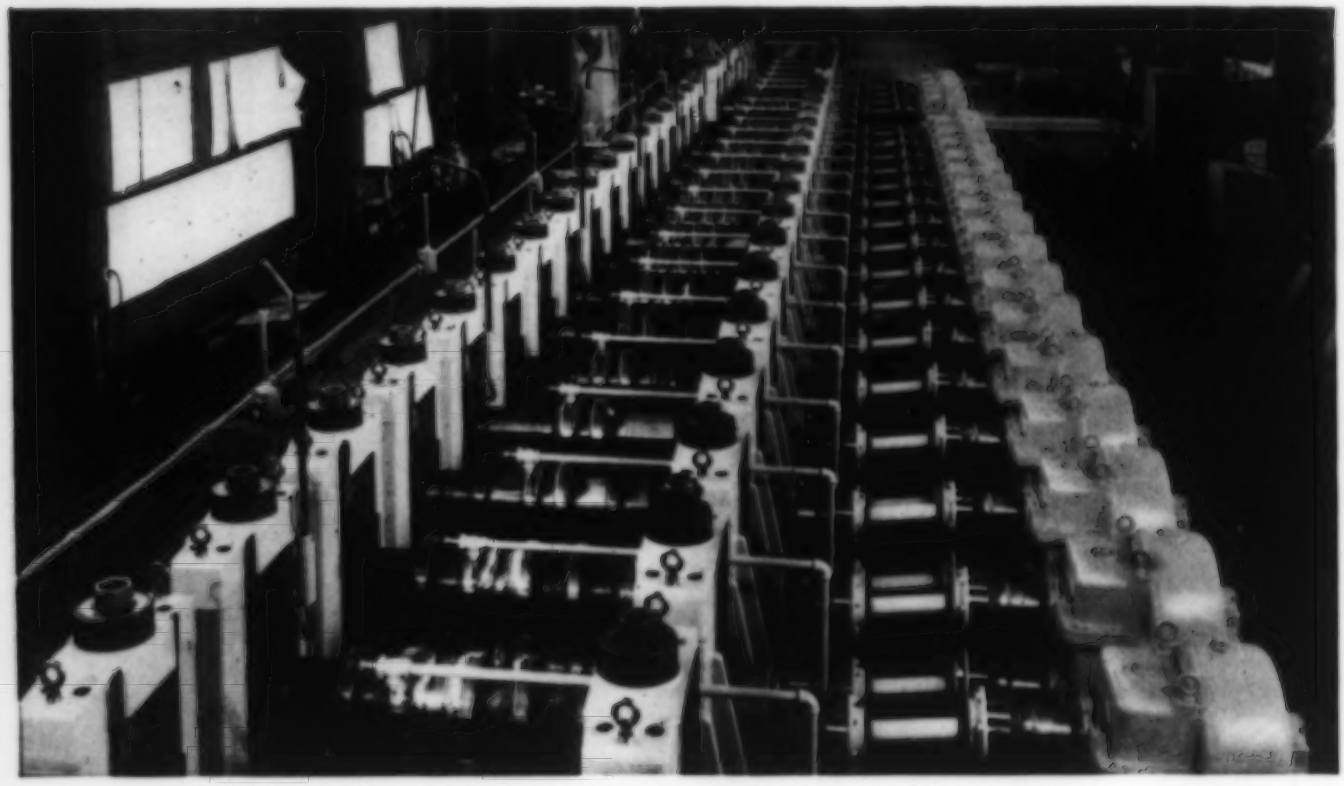
MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



Whether you require 84 joints or 1—you can put to use these Rzeppa advantages

Pictured is the most advanced and largest cold forming mill in the world—developed by the American Roller Die Corporation. In it, 84 Rzeppa Constant Velocity Universal Joints are providing money-saving precision never before possible in this industry.

Here are the advantages you can receive by specifying Rzeppa Joints:

- **Stepped-up speeds.**
- **Reduced down-time.**
- **Smooth flow of power at unbalanced angles.**
- **Higher capacity for size and weight.**

HOW TO GET COMPLETE INFORMATION ON THE PROFIT ADVANTAGES OF RZEPPA JOINTS

You can get more information on how Rzeppa Joints can fit into your joint application. Write, wire, or phone today. We'll send the brochure or have a factory representative call —as you wish.

RZEPPA

(Pronounced "SHEPPA")

CONSTANT VELOCITY

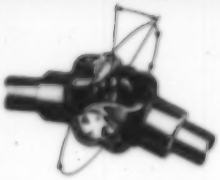
UNIVERSAL JOINTS

The Gear Grinding Machine Company 3937 Christopher Detroit 11, Michigan

Manufacturers of • Fully Automatic Gear Grinding Machines
• THE DETROIT SCREWMATIC 750

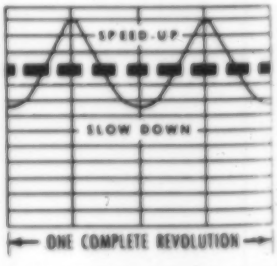
COMPARISON OF OPERATION

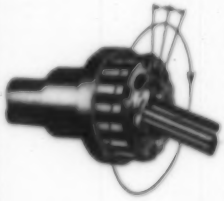
Rzeppa Versus Pin or Slipper-Type



During rotation at a given angle, pin or slipper-type joint speeds up, slows down twice during one revolution.

Solid line shows speed variation for one revolution of pin or slipper-type joint at a critical angle. Note constant velocity of 100% for Rzeppa Joint (dotted line).





Due to its construction features, the Rzeppa Joint always transmits a smooth flow of power even at unbalanced angles. The standard joint cannot meet this test without involved compensating measures.

You can order 52100 tubing right now...

we'll ship tomorrow

WHEN you need 52100 steel tubing in a hurry, get us on the phone. We'll ship the next day. We stock 101 different sizes of Timken® 52100 steel tubing —from 1″ to 10½″ O.D. All of them are available for less-than-mill-quantity orders.

Timken 52100 steel can be used for most hollow parts jobs and many manufacturers have substituted it for more expensive steels. A high-carbon chrome steel, it's through-hardening in moderate sections. It can be heat-treated to file hardness and tempered back to any desired point.

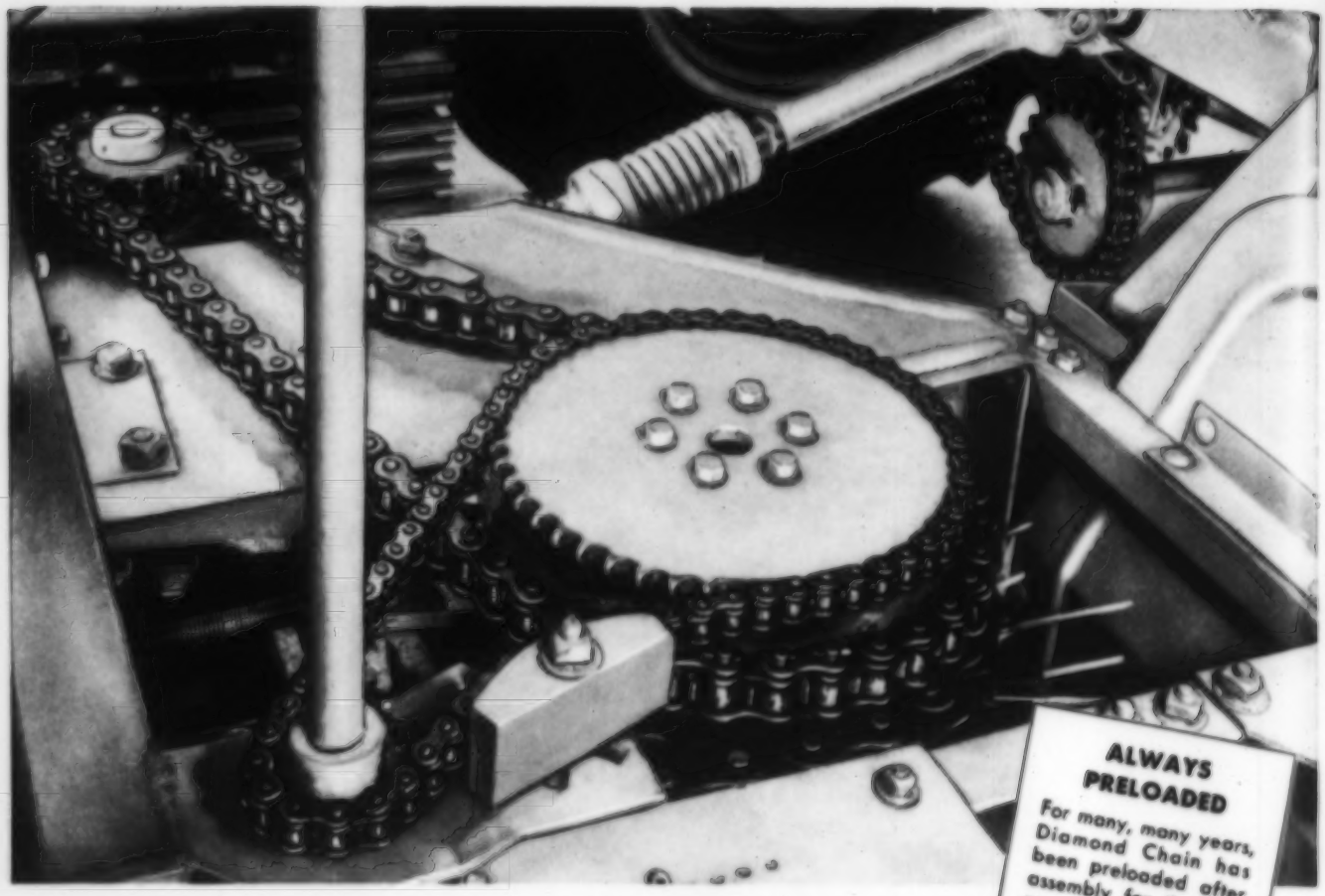
Here are some of the jobs 52100 is now being used for: aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts and precision instrument parts.

The Timken Company is America's pioneer producer of 52100 tubing. We have an unequalled backlog of experience and as a result we can give you uniform quality from tube to tube—order to order. Every step of production is rigidly checked.

For immediate delivery of your less-than-mill-quantity orders, write or phone The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



ALWAYS PRELOADED

For many, many years, Diamond Chain has been preloaded after assembly for the purpose of bringing pin-bushing seating into stabilized relationship prior to field installation.

HOW ELSE CAN SEVERAL MOTIONS BE COORDINATED SO ECONOMICALLY?

Plant production engineers and executives, and machinery designers have found thousands of applications for Diamond Roller Chain during the past 65 years . . . They have found many times that results are accomplished that would be very difficult by any other means.

Performance is assured with economy in first cost and maintenance. High efficiency, long-life non-slipping operation and the universally recognized high uniform quality continue to make Diamond Roller Chain first choice.

Our experienced engineering staff is ready at all times to make practical recommendations.

DIAMOND CHAIN COMPANY, Inc.

Where High Quality is Traditional

Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

Write for Catalog 754 Stock Roller Chains and Sprockets

Contents include:

- How to select Stock Roller Chain Drives
- Ready-to-use chain length tables.
- Table of speed ratios for sprocket combinations
- Sprocket selection tables for chains, all pitches
- Stainless Steel and Bronze chains

The Roller Chain is **DIAMOND**

TRADE ◇® MARK

DU PONT

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NEWS

NO. 9 — 1955

LUCITE® proves ideal for See-Thru panels in new G-E kitchen ventilator

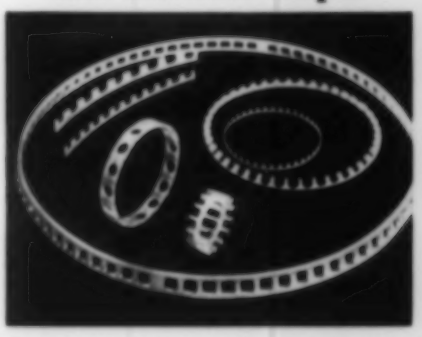
Clear, adjustable panels of "Lucite" are shatterproof and moisture resistant

New G-E kitchen ventilator has adjustable panels of sparkling "Lucite" acrylic resin. Du Pont "Lucite" resists aging and moisture . . . features high impact strength, even at relatively low temperatures.

THE ADJUSTABLE See-Thru panels on the new G-E kitchen ventilator required an unusual combination of properties. A lightweight, easily fabricated material was needed. It had to have excellent optical quality and still be durable enough to withstand vibration, moisture and harsh weather. The engineering material chosen was molded Du Pont "Lucite".

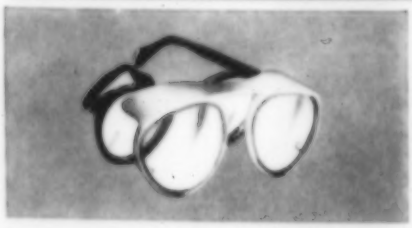
"Lucite" has outstanding strength and wearing properties that assure long service life and eliminate disturbing rattles. It has the sparkling transparency of optical glass. To find out how "Lucite" can help solve your design problems, clip and mail the coupon.

"Zytel" can be molded into intricate shapes



Design engineers specify "Zytel" nylon resin for a great variety of product designs where its ability to be molded into intricate shapes proves desirable. Single parts of "Zytel" often replace multi-part assemblies of other materials. The moldability of "Zytel" nylon resin is well illustrated by the seven samples of molded bearing cages shown above. Cages manufactured by the Kaydon Engineering Company, Muskegon, Mich.

OVER



New "Eye Savers" feature lightweight, unbreakable frames of ALATHON®

THE FRAMES of these attractive, clip-on eye savers are molded of Du Pont "Alathon" polyethylene resin. They are so light in weight—"Alathon" has a specific gravity of 0.91—that they can be worn all day with comfort. In addition, "Alathon" resists weather and impact, and is strong in thin sections. For such decorative applications, "Alathon" is available in a variety of colors or attractive translucent textures. (Tuc-Over Eye Savers are manufactured by Watchemoket Optical Company, Inc., Providence, Rhode Island.)

DU PONT

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

PRODUCTS ENGINEERING NEWS

NO. 9 — 1955

Conduit fittings of ZYTEL® are economical, reduce galvanic corrosion

Installing a conduit fitting molded of "Zytel". Note component parts in foreground. A neoprene grommet incorporated in design enables 9 sizes of these fittings to do the job of 27 sizes of former metal fittings. Parts of "Zytel" molded by Danielson Manufacturing Company, Danielson, Connecticut.

ENGINEERS are finding new ways to simplify design and reduce costs by substituting parts of "Zytel" nylon resin for parts of metal or other conventional materials. An outstanding example of a more efficient design is this new conduit fitting used by the U. S. Navy to form a tight seal where cables enter terminal boxes.

As replacements for traditional fittings of metal, the parts molded of "Zytel" offer a saving of 80% in weight. (This amounts to 30-45 tons on an aircraft carrier.) The nylon fittings are less expensive to produce, easier to handle. And, because of the improved design of the new fittings, 9 sizes do the job of 27 sizes of the old. The Navy estimates a saving of $31,000 on a typical ship with fittings of "Zytel".

"ZYTEL" also offers mechanical advantages

"Zytel" is not subject to salt-water and galvanic corrosion, a frequent source of trouble with metal fittings aboard ship. Its high impact strength and resistance to heat and abrasion are other important advantages in electrical applications. *You* may have a product or process that will be improved by utilizing the properties of molded Du Pont "Zytel" nylon resin. Clip and mail the coupon for further information.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 1212, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ ***"Zytel"***; ☐ ***"Alathon"***; ☐ ***"Teflon"***; ☐ ***"Lucite". I am interested in evaluating these materials for:***

NAME _____ POSITION _____

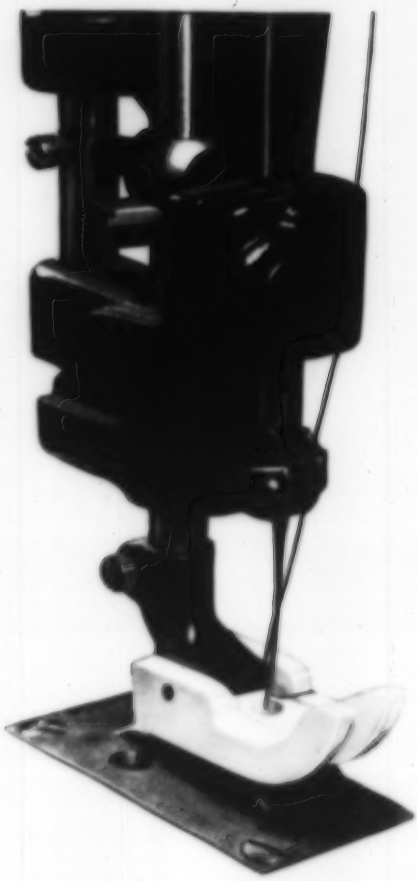
COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

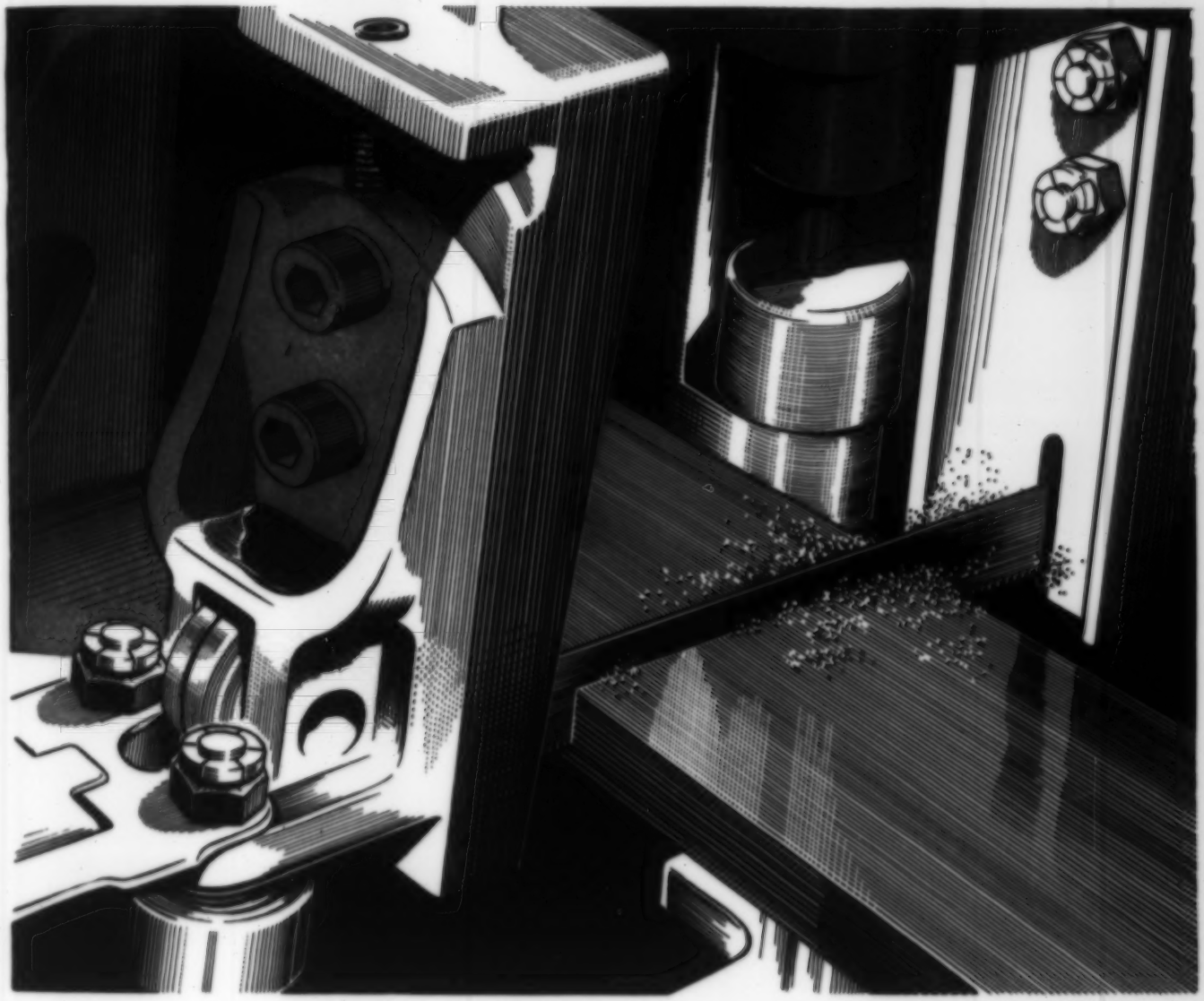


Smooth, low-friction surface of TEFLON® improves presser foot operation

THIS presser foot, used on industrial sewing machines, is now molded of "TEFLON" tetrafluoroethylene resin. The foot guides material as it goes under the needle. The machine is designed primarily for sewing difficult materials such as rubberized fabrics. "TEFLON" has a low-friction surface which improves the mechanical operation of the sewing machine and eliminates need for a walking foot mechanism. (Manufactured by the Chase Sales Company, Hayward, California.)

For complete details on this outstanding Du Pont engineering material, mail the coupon at left.

FLEXLOC AT WORK



Power Hack Saw Builder Fastens blade guides with FLEXLOC self-locking nuts. Eight of these one-piece, all-metal locknuts are used in this assembly. And they won't work loose, regardless of vibration.

You can get the same dependable service. FLEXLOCs come in a wide range of sizes, types and materials. They are stocked by leading industrial distributors everywhere. Ask your local man for Bulletin 866. Or write STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

• • •

Use FLEXLOCs anywhere:

ON ROUGH BOLTS. FLEXLOCs smooth out bolt threads without damaging their own threads.

IN TEMPERATURES TO 550° F. in plated nuts and even higher in unplated ones. High temperatures do not affect FLEXLOCs. Nuts with non-metallic inserts fail under such conditions.

AS LOCK OR STOP NUTS. After at least 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC stays put.

REGARDLESS OF MOISTURE, OIL, DIRT AND GRIT. Even conditions like these do not affect the locking ability of FLEXLOCs.

FLEXLOC®
LOCKNUT DIVISION
sps
JENKINTOWN PENNSYLVANIA

Logan air valves

A model to effectively meet practically any air control valve requirement.
Designed to assure maximum efficiency with a minimum of maintenance.

Model 6350
Air Control Valve

82 models

most models stock delivery

Logan Air Control Valves are designed and built to assure an unusually high standard of performance plus maximum convenience for the design engineer, machine operator and maintenance man. Every construction detail has been planned to make Logan valves easy to install, to use and to service.

Thousands of manufacturers have found Logan valves to be the answer to their production problems. Logan engineers are at your service to help you achieve better, more efficient production. Following are a few facts about Logan Air Control Valves:

Standard valve models are available in a wide range of mounting types, means of actuation, type of handle and sizes.

Can be located in any position on horizontal, vertical or other surfaces. Mounting is simple.

Construction is compact—permits installation in limited space, close to other equipment.

All valves are built for operating pressures to 150 psi. For reuse, many Logan valves can easily be converted to other types. Parts are interchangeable.

The wide choice of types of control makes it possible to provide the most convenient type of actuation for every problem of regulation.

Effortless control is provided in all models. Balanced construction produces equal pressure on both sides of piston.

Valve piston is light in weight, permitting high-speed operation without excessive vibration or wear.

Long-life synthetic rubber cup packings on valve piston assure positive action without leakage.

Piston-type valve with sliding piston eliminates valve seats; minimizes wear.

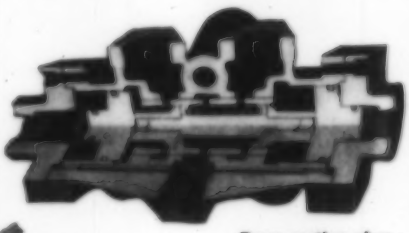
Self-cleaning construction means longer sealing life.

Valves are unusually easy to repair or recondition. Simply by removing cover screws—covers and valve piston can be quickly removed and replaced.

If a few spare pistons are carried in stock, a Logan air valve can be reconditioned with only a few minutes of downtime. Write for Logan Catalog 100-4.

Model 6241
Air Control Valve

Cross-section view of Model 6350



Cross-section view of Model 6241

Let Logan Engineers help you design your Air and Hydraulic Circuits. No obligation.

MEMBER—
National Machine Tool Builders Assn.
National Fluid Power Assn.

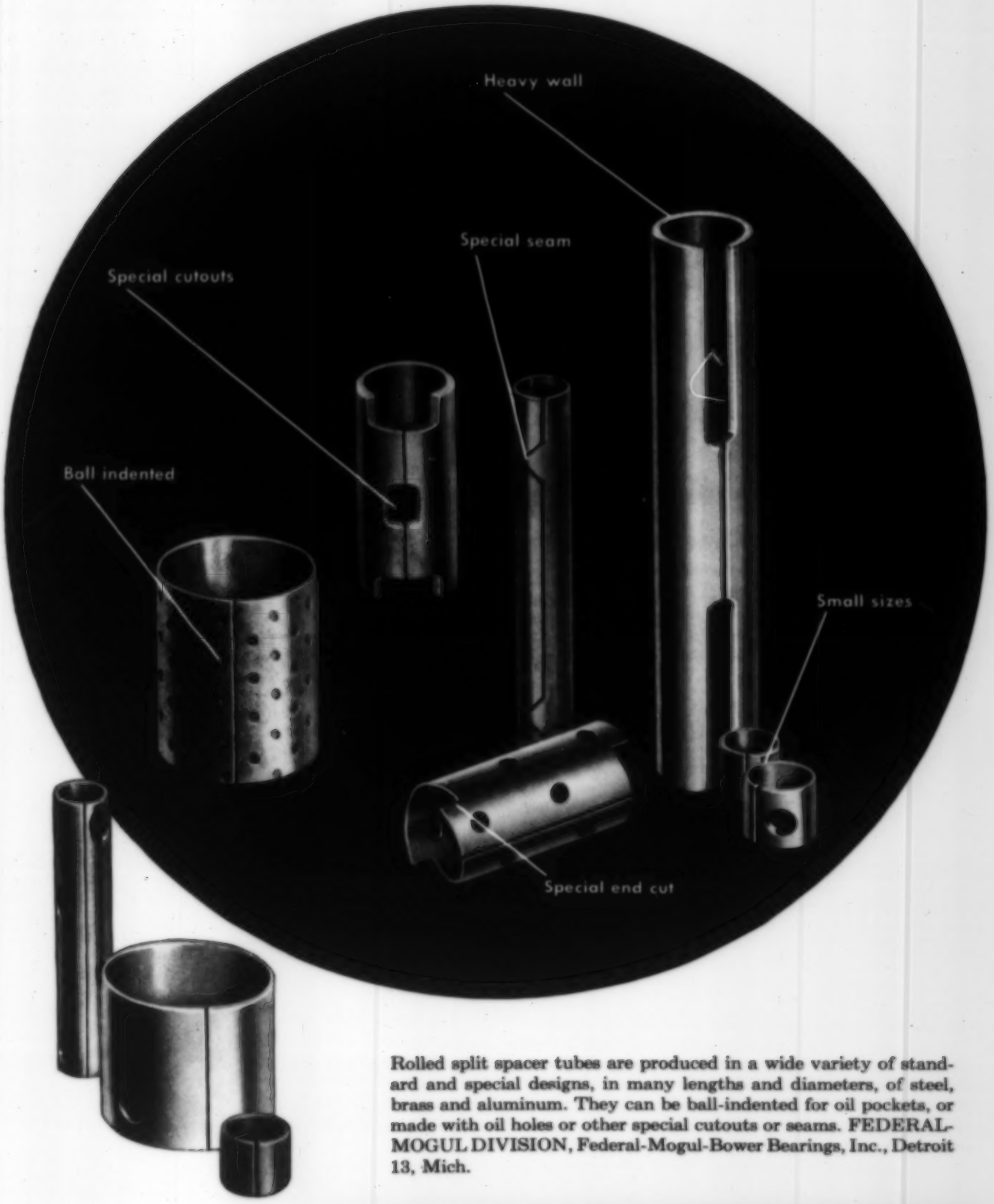
LOGAN MANUFACTURES 7,023 STANDARD CATALOGED ITEMS

FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3
AIR and HYDRAULIC PRESSES, Cat. 51 • COLLET GRIP TUBE FITTINGS, Cat. 200-5 • HYDRAULIC CONTROL VALVES, Cat. 200-4
HYDRAULIC CYLINDERS, Cats. 200-2; 200-3 • HYDRAULIC POWER UNITS, Cat. 200-1 • SURE-FLOW COOLANT PUMPS, Cat. 42

SAVES TIME Logan AIR AND HYDRAULIC EQUIPMENT SPEEDS MOTION

LOGANSPORT MACHINE CO., INC., 811 CENTER AVE., LOGANSPORT, IND.



Rolled split spacer tubes are produced in a wide variety of standard and special designs, in many lengths and diameters, of steel, brass and aluminum. They can be ball-indented for oil pockets, or made with oil holes or other special cutouts or seams. FEDERAL-MOGUL DIVISION, Federal-Mogul-Bower Bearings, Inc., Detroit 13, Mich.

FEDERAL Mogul since 1899

FEDERAL-MOGUL

Sleeve bearings, bimetal rolled split bushings, plain steel or bronze rolled split bushings, bearing-surfaced washers.

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● **Since 1867 engineers, scientists, designers, surveyors, draftsmen have relied on K&E as the foremost, most progressive, and most complete source of supply for the tools, equipment, and materials they work with. When you buy, think first of K&E, headquarters for 7,000 items. For example...**

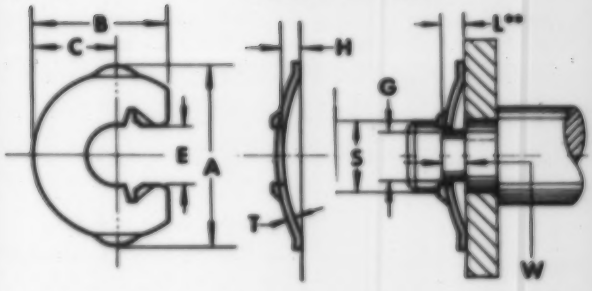
ZEISS Ni2
SELF-LEVELING LEVEL

This amazing new instrument cuts leveling time and costs in half. It sets a line of sight precisely level *automatically*. A remarkable new invention, the Compensator, built into the telescope levels the line of sight for you in a matter of moments. It performs any kind of leveling, from rough cross sectioning to first order work. Bench-mark leveling, using two rods, is almost twice as fast with the Ni2 as with an ordinary level. Cross-sectioning with many sights from one set-up is even faster. Accurate up to ± 0.02 ft. per mile, the Ni2 is as rugged as its appearance suggests.

KEUFFEL & ESSER CO.
New York • Hoboken, N. J.
Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles
Seattle • Montreal
Distributors in Principal Cities

New Waldes Truarc locking-prong ring functions as spring, shoulder, fastener... and STAYS PUT!

Above assembly shows how 2 Waldes Truarc Locking-Prong Rings (Series 5139) replaced 6 parts... eliminated threading operation... and need for skilled labor.



WALDES TRUARC LOCKING-PRONG RING (Series 5139)

U. S. Pat. Pending

Ring No. 5139-	SHAFT		RING DIMENSIONS												average ultimate shear strength lbs.*	GROOVE DIMENSIONS					resilient end play take up L max.– L min
	Dia. S	tol.	A	tol.	B	tol.	C	tol.	E	tol.	H	tol.	T†	tol.†		Dia. G	tol.	Width W	tol. –.000	L min.	L max.	
12	.125	±.002	.340	±.010	.307	±.010	.166	±.005	.086	±.004	.050	±.010	.010	±.0013	400	.082	±.0015	.045	+.005	.035	.045	.010
★15	.156	±.003	.380	±.010	.330	±.010	.184	±.005	.108	±.004	.055	±.010	.010	±.0013	600	.104	±.002	.050	+.005	.035	.045	.010
18	.188	±.003	.445	±.010	.390	±.010	.213	±.005	.130	±.005	.060	±.010	.015	±.0015	900	.124	±.002	.065	+.005	.045	.055	.010
25	.250	±.003	.581	±.010	.500	±.010	.280	±.005	.172	±.005	.070	±.010	.015	±.0015	1000	.165	±.002	.070	+.005	.050	.065	.015
31	.312	±.003	.744	±.010	.620	±.010	.360	±.005	.234	±.005	.095	±.010	.018	+.001 –.002	1300	.228	±.003	.080	+.005	.080	.095	.015
★37	.375	±.003	.853	±.015	.740	±.010	.427	±.005	.280	±.005	.130	±.010	.020	±.002	1900	.270	±.003	.105	+.005	.090	.115	.025
★43	.438	±.003	.960	±.020	.820	±.020	.475	±.010	.337	±.010	.130	±.010	.020	±.002	2200	.327	±.003	.105	+.005	.095	.120	.025

Additional Sizes Under Development ★Production dies not available as of date of printing †Applies to unplated rings only *Recommended safety factor —3 to 4.

The Waldes Truarc Locking-Prong Retaining Ring is a new, low cost, radially applied fastener which can be locked positively in its groove and used as a shoulder against rotating parts. It is primarily intended for use in the automotive, electronic and aeronautical industries.

This radially applied ring locks positively in its grooves by means of two prongs at the open end. Because of its high thrust-load capacity the Waldes Truarc Locking-Prong Ring may be used as a shoulder against rotating parts. Its bowed construction provides for end-play take-up in the assembly and makes less critical the tolerances required for the parts being fastened. Since it serves as a spring as well as a shoulder, this ring eliminates the need for springs, washers, and other accessory fastening devices.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Locking-Prong Rings. (please specify shaft size_____)

☐ Please send me supplement No. 1 which brings Truarc Catalog &c 9-52 up to date.

(Please print)

Name_____

Title_____

Company_____

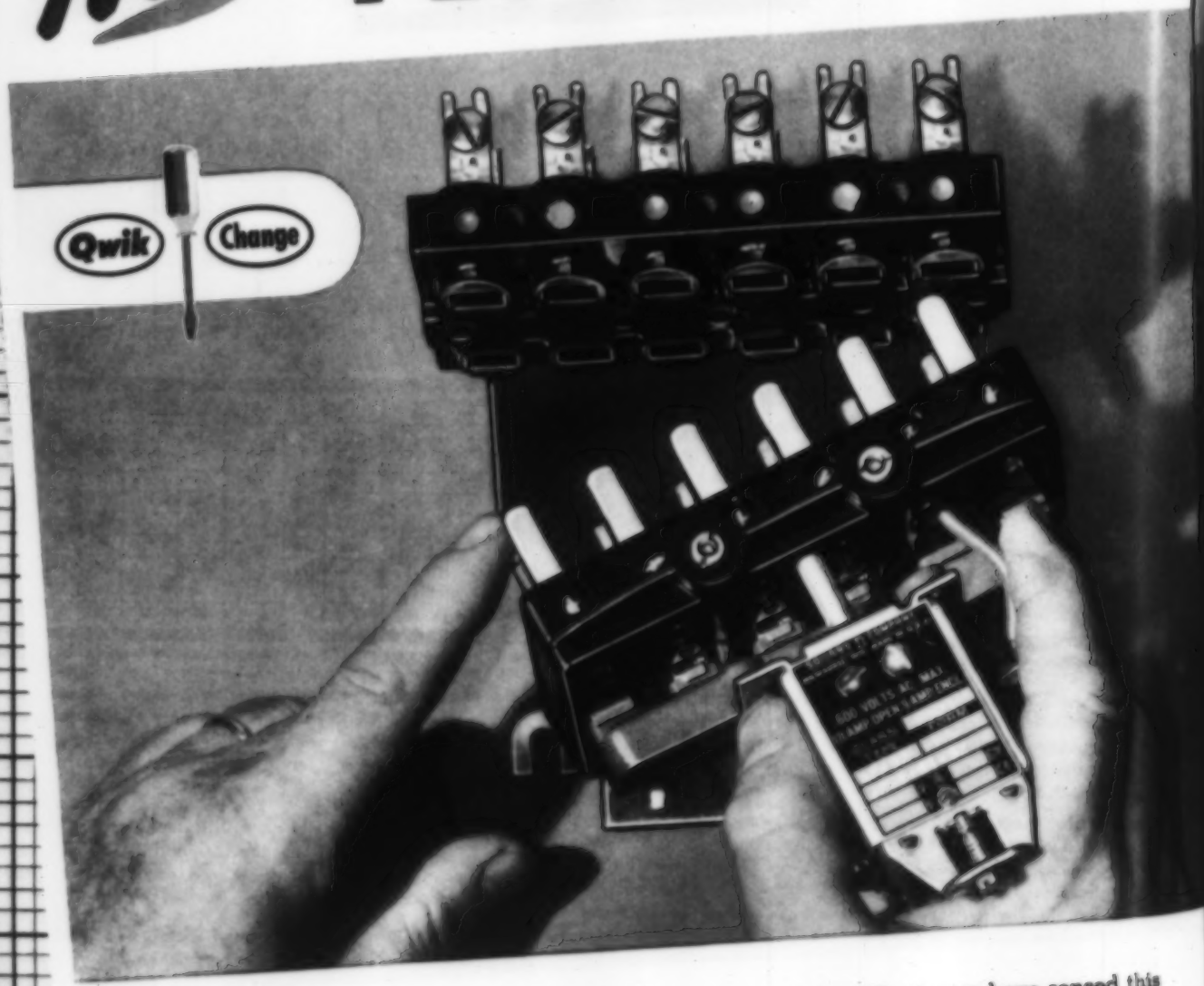
Business Address_____

City_____ Zone_____ State_____

49-EF

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787. and other U. S. Patents pending. Equal patent protection established in foreign countries.

Now PLUG-IN RELAY



• A screwdriver and five seconds are all you need to remove this new **PLUG-IN** relay for normal inspection, maintenance or replacement! That's big news in these days of "pushbutton" operations when even a few minutes of down-time can mean thousands of production dollars down the drain.

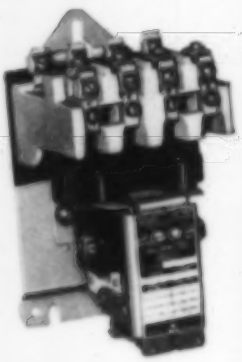
Square D Field Engineers have sensed this ever-increasing problem in their contacts with machine tool builders and industrial plants throughout the country. Square D design engineers have followed through with this, the first plug-in relay built specifically for machine tool use. Another example of design leadership!

Write **for Bulletin 8501**
Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin

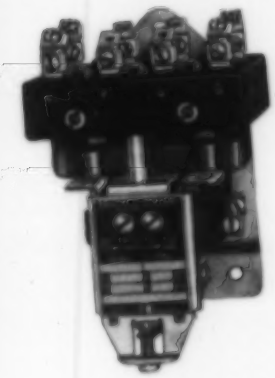
SQUARE D COMPANY

for Machine Tool Service!

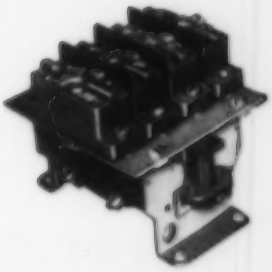
HERE ARE THE OTHER MEMBERS OF SQUARE D's RELAY TEAM



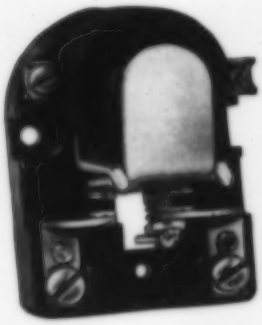
TYPE B
(15 Amperes, 600 Volts) Heavy-duty construction with hardened parts for very severe machine tool service



TYPE A
(10 Amperes, 600 Volts) Designed for general-purpose applications involving normal operations

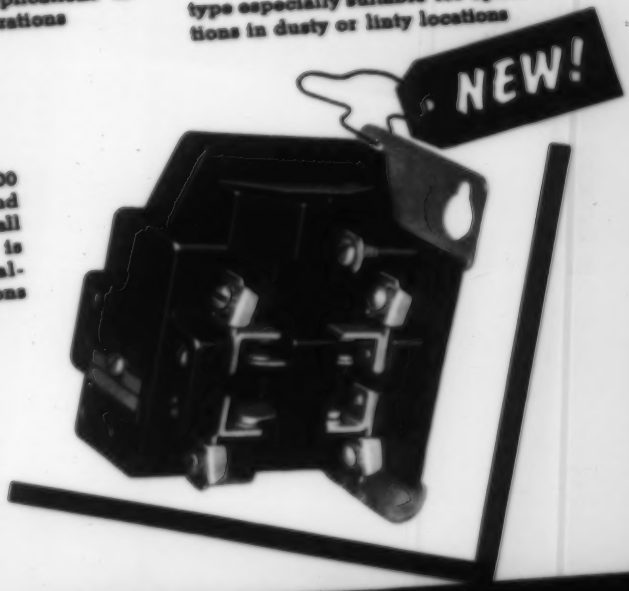


TYPE P
(Rated 10 Amperes, 600 Volts) Totally-enclosed contacts make this type especially suitable for operations in dusty or linty locations

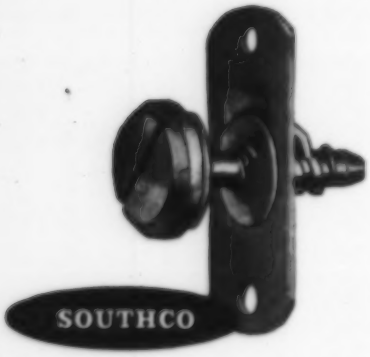


TYPE C
Used as auxiliary devices for controlling small, single phase motors or other light loads

TYPE D
(Rated 10 Amperes, 600 Volts) This new and most compact of all Square D relays is ideal for general-purpose applications involving very limited space



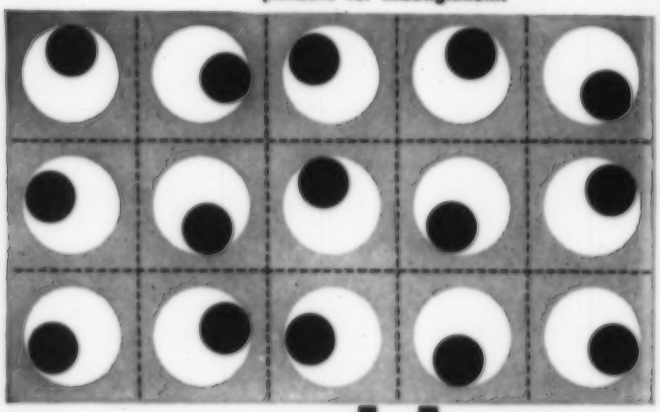
ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS



a quick release fastener that...

solves alignment problems

Illustration indicates infinite variety of positions assumed by screw fastener to compensate for misalignment.



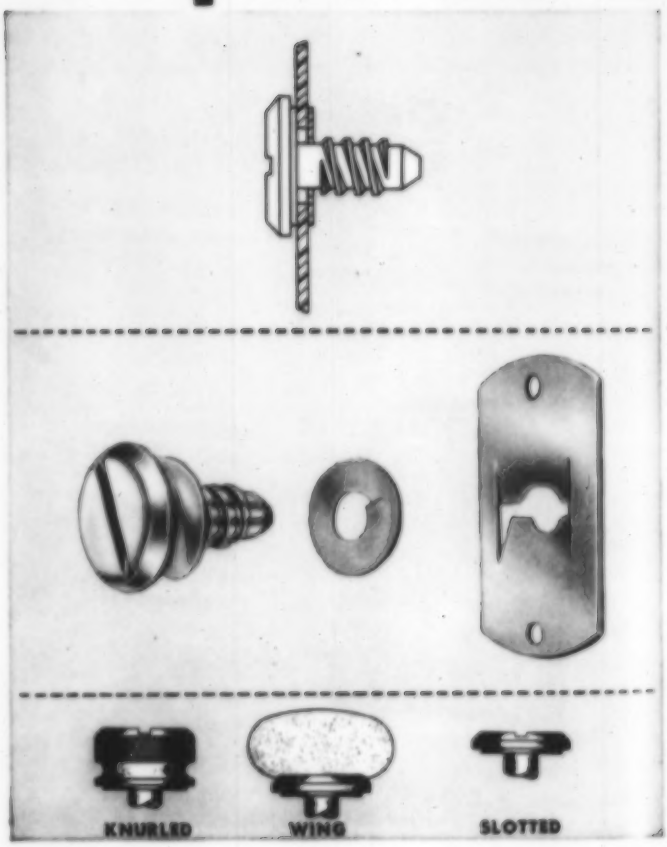
"FLOATING SCREW" ASSEMBLY COMPENSATES FOR OUT-OF-LINE DOORS AND PANELS

Installation of access doors and panels is made easy and production is speeded with Southco Quick-Release Fasteners. The wide alignment tolerances of Southco's "Floating Screw" adjust automatically to misalignment, saving mechanics' time. Also, the Southco "Floating Screw" insures accurate and uniform closure throughout the life of the equipment, compensating for warpage and bends resulting from hard usage.

One Southco grip length can meet most panel thicknesses on the average assembly—no need to specify many fastener sizes!

For complete information, write Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

© 1954



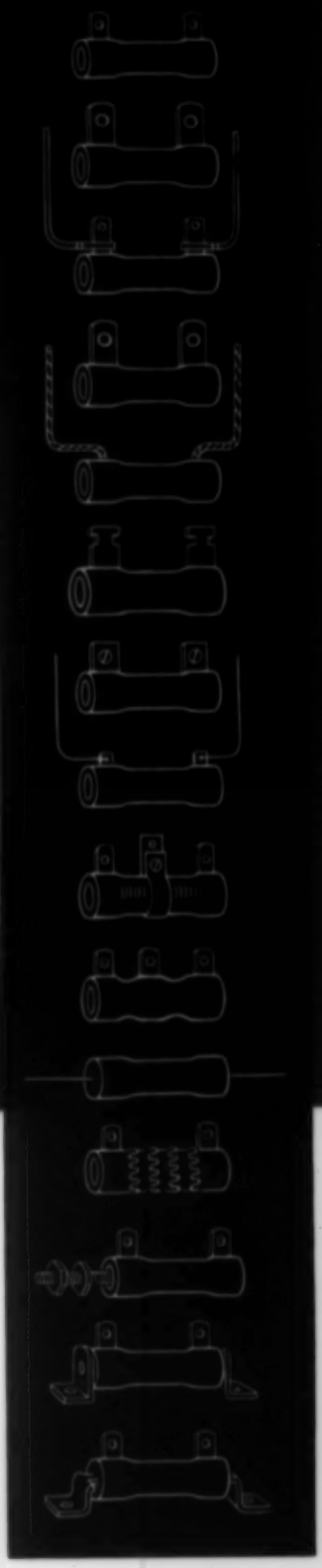
SOUTHCO

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS



NOTE all diameters and lengths are identical. Photo twice actual size.

How do you want your 10-watt resistors?

Here are a few of the variations you can get in basic design, terminals and mountings on a standard 10-watt Vitrohm resistor.

It's this tremendous variety (we make a wider range of resistors than anybody else) that enables Vitrohm resistors to do so many jobs so well – and save you installation costs at the same time.

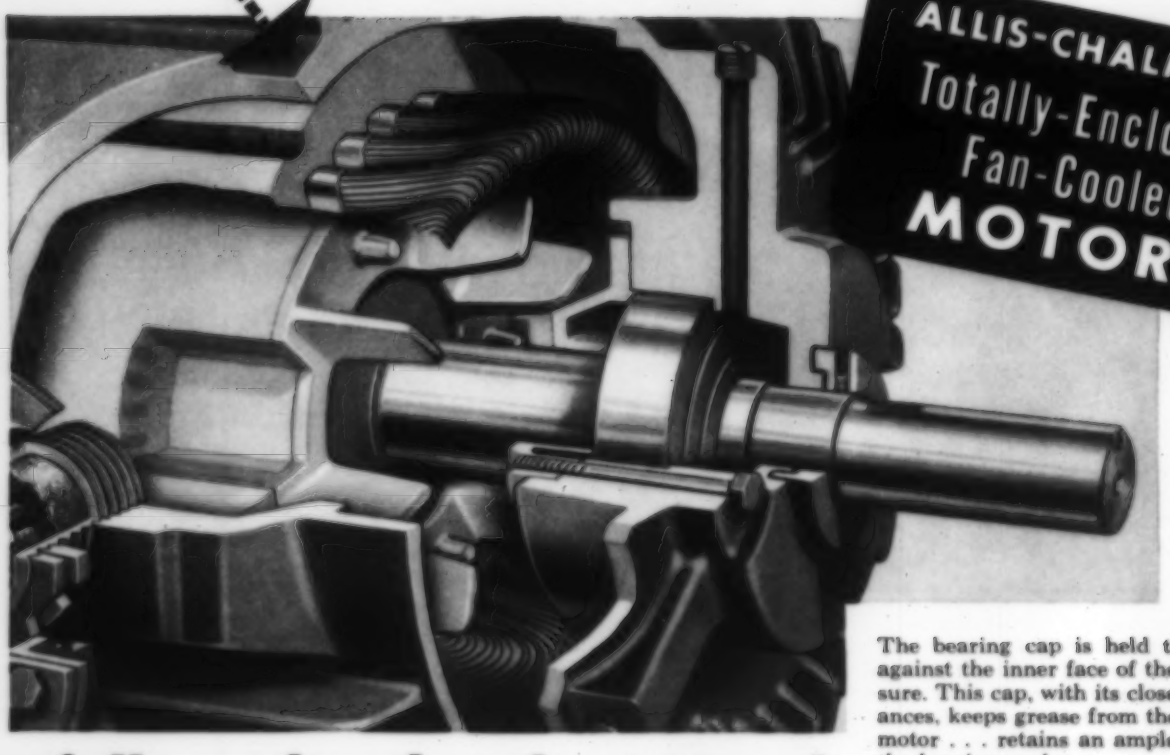
Add to this Ward Leonard's performance standards – insured by the 19 separate inspection tests we run on every single resistor we make – and you see why you get more resistor for your money in a Vitrohm.

Prompt delivery, too, by the way.

Our engineers will be glad to show you which Vitrohm design best meets your specific needs. A line or call to Ward Leonard Electric Company, 58 South Street, Mount Vernon, N.Y. is all it takes. 5.4

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Get Both
bearing features

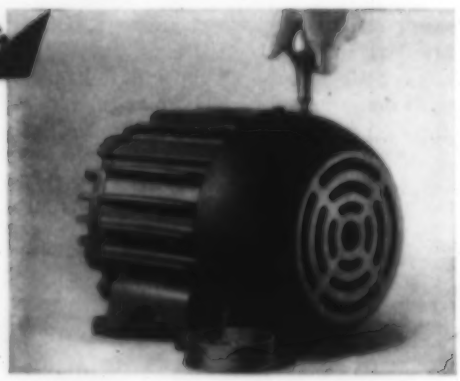


fully enclosed and protected

The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

. . . yet easy to grease

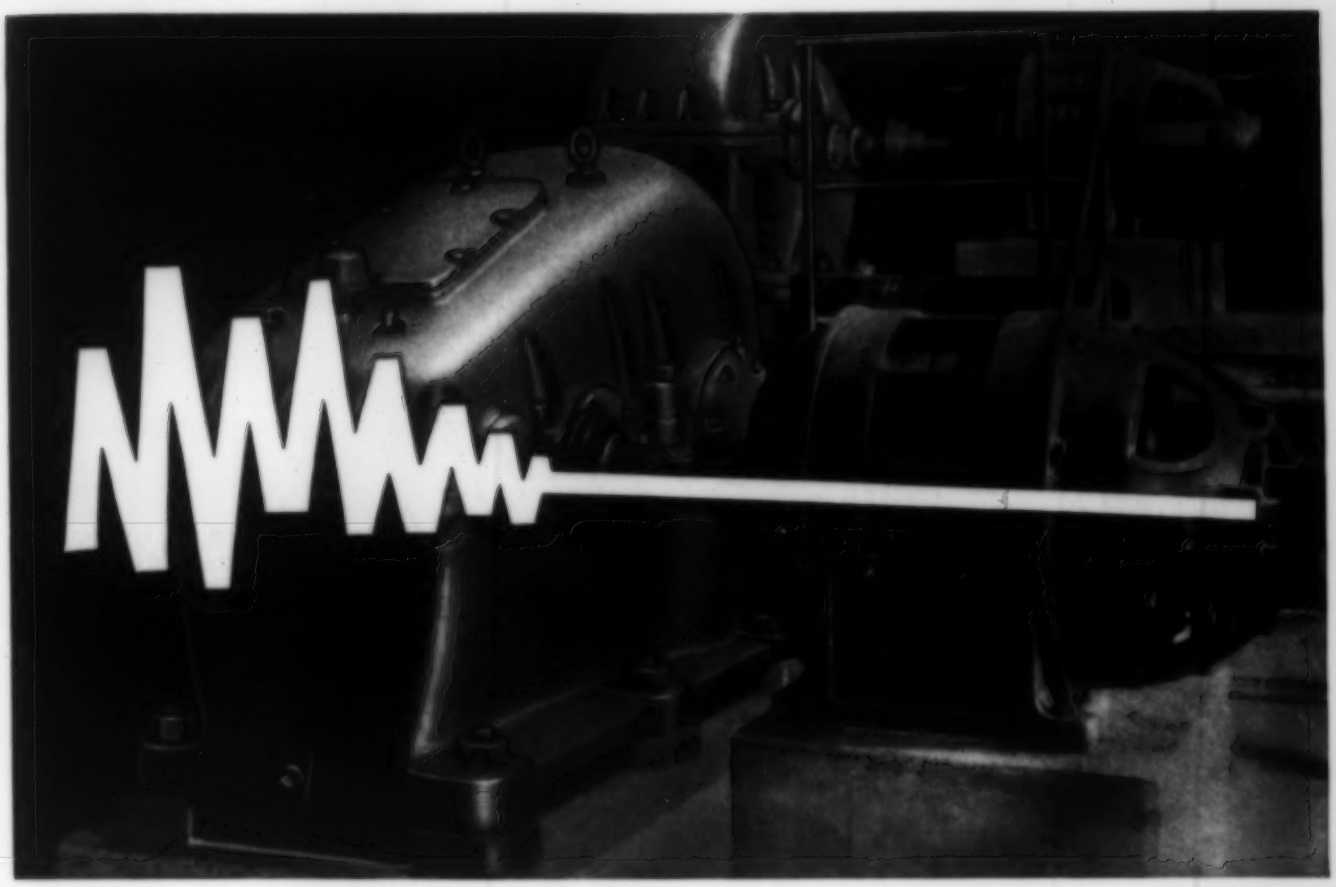


You can lubricate the bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at three points provide both means for inserting new grease and a means of flushing out old grease.

Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7225.

A-4609

ALLIS-CHALMERS



Compact, rugged Link-Belt Parallel Shaft Drive "shrugs off" shock loads. Available with ratios up to 300:1 and horsepower capacities to over 2000.

Rugged LINK-BELT Parallel Shaft Drives

"shrug off" shock loads

WHEN it comes to judging a drive's resistance to shock and frequent overloading, ratings tell only half the story. It's these construction refinements of Link-Belt Parallel Shaft Drives that give you further assurance of long-range speed reduction economy:

GEARS are precision machined, shafts rigidly supported.

BALL AND ROLLER BEARINGS are used throughout.

GREASE-LUBRICATED SEALS block shaft openings to dirt.

AUTOMATIC SPLASH LUBRICATION cuts maintenance.

You'll find, too, that Link-Belt has simplified inspection and maintenance by making all parts accessible without disturbing the base. And to prevent reverse rotation on conveyors, elevators and similar equipment, a built-in backstop can be provided.

There are many more facts worth knowing—as well as specifications and application data — in Book 2619, available from your Link-Belt office. Write today.

Get JOB-MATED drive combinations from the complete Link-Belt line

In addition to parallel shaft gear drives, Link-Belt builds in-line helical and worm gear drives, Gearmotors, Motogears, variable speed drives, fluid drives, chains, sprockets, couplings, bearings, etc. All are pre-engineered for easy installation and maximum efficiency.

LINK-BELT

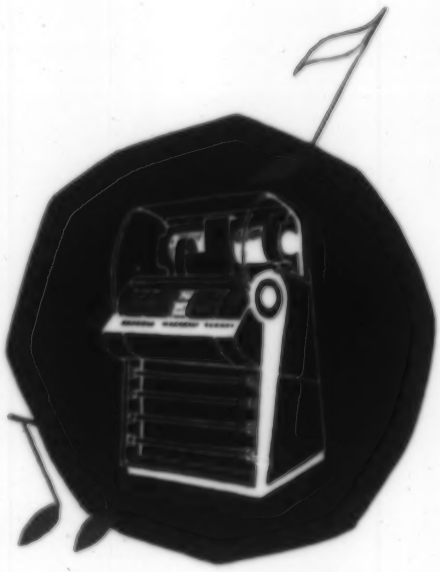
ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13,055-A

sound from silence . . . .

The J. P. Seeburg Corp. has worked hand in hand with The United States Graphite Company in developing self lubricating bearings and parts which meet the exacting requirements of the most successful high fidelity coin operated phonograph made today.



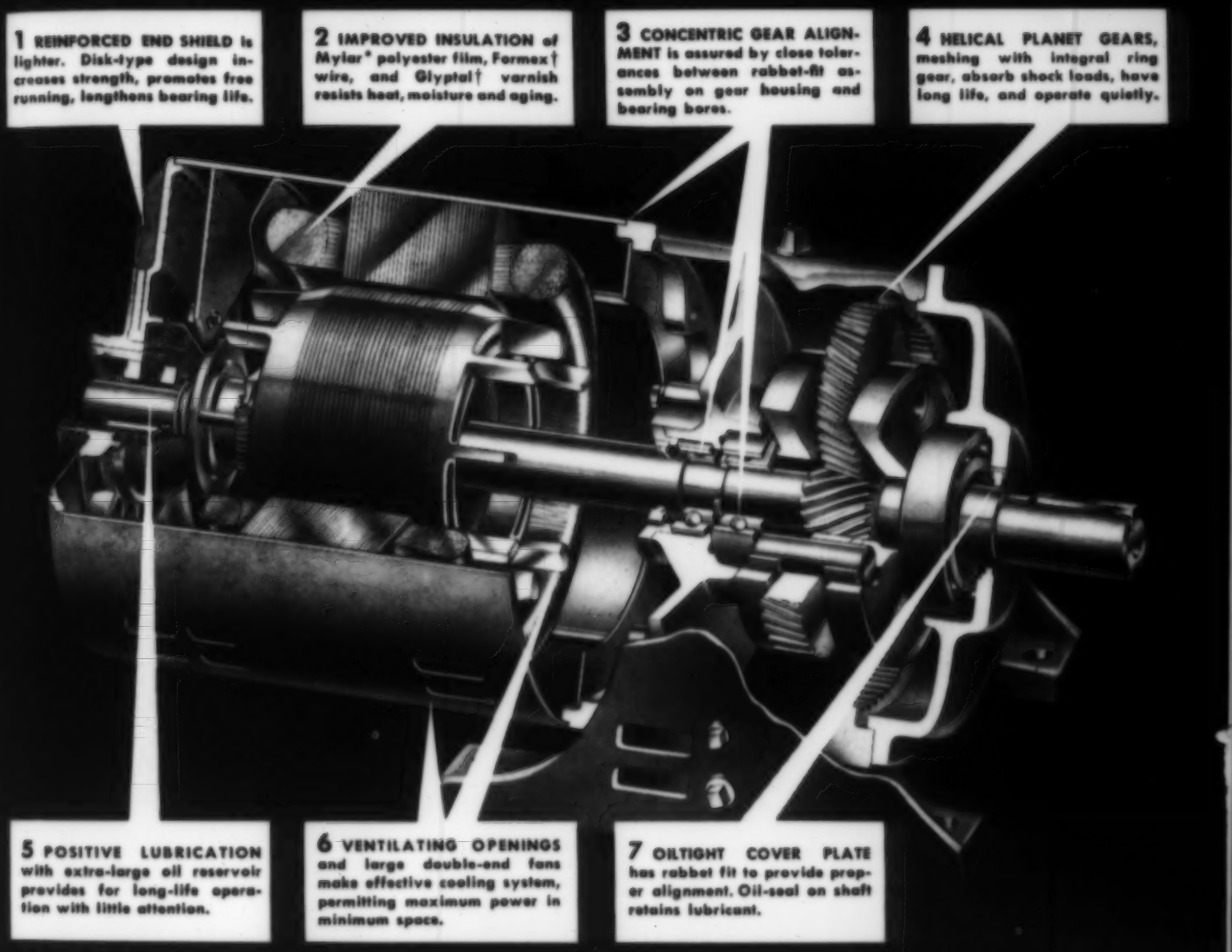
GRAMIX®

products from powder metallurgy

112

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN


1 REINFORCED END SHIELD is lighter. Disk-type design increases strength, promotes free running, lengthens bearing life.
2 IMPROVED INSULATION of Mylar* polyester film, Formex† wire, and Glyptal† varnish resists heat, moisture and aging.
3 CONCENTRIC GEAR ALIGNMENT is assured by close tolerances between rabbet-fit assembly on gear housing and bearing bores.
4 HELICAL PLANET GEARS, meshing with integral ring gear, absorb shock loads, have long life, and operate quietly.
5 POSITIVE LUBRICATION with extra-large oil reservoir provides for long-life operation with little attention.
6 VENTILATING OPENINGS and large double-end fans make effective cooling system, permitting maximum power in minimum space.
7 OILTIGHT COVER PLATE has rabbet fit to provide proper alignment. Oil-seal on shaft retains lubricant.

These 7 features of NEW G-E gear-motors assure better operation and longer life

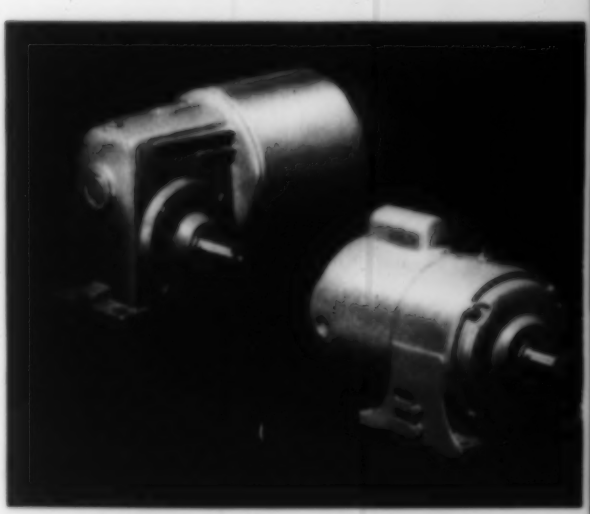
Advanced design features make new General Electric fhp gear-motors the best answer to your low-speed-drive needs. Seven top features for improved operation and longer life are described in the illustration above.

YOU SAVE 4 WAYS with these new G-E fhp gear-motors: (1) On ordering—only one unit to select instead of several. (2) On installation—unit construction saves time and trouble. (3) On space—they're the most compact low-speed drives available. (4) On operation—features mean low maintenance, long life.

WHATEVER YOUR LOW-SPEED DRIVE NEEDS—for plant use or to power your products—you can get the right gear-motor from your G-E Apparatus Sales Office or Distributor. Ratings range from ¼ to ¾ hp, 520 to 6 rpm. Ask about "off-the-shelf" delivery on 56 popular ratings. Or write Sect. 702-17, General Electric Co., Schenectady 5, N. Y.

*du Pont Trademark
†Reg. Trademark of General Electric Co.

GENERAL ELECTRIC



BOTH RIGHT-ANGLE SHAFT and concentric-shaft models are available in the full line of new G-E fhp gear-motors. Long-life features above apply to both.

need quick service on TIMERS for automatic control?

Time Delay Timers

The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

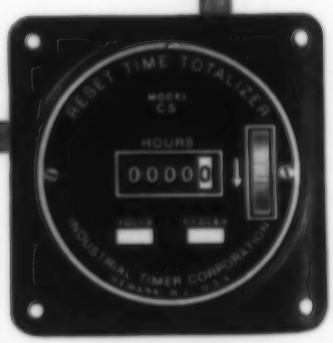
We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.

Interval Timers

Re-Cycling Timers



Running Time Meters

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

131 OGDEN STREET, NEWARK 4, N. J.

Your latest reference to better production

NEW J & L BOOKLET ON

EXTRUDED SECTIONS

WITH J&L EXTRUDED SECTIONS YOU CAN:

1. **ELIMINATE** time and costs in machining operations.
2. **ELIMINATE** time and costs in finishing operations.
3. **REDUCE** scrap losses practically to the zero point.
4. **ELIMINATE** the cost of castings and forgings of intricate sections requiring considerable machining.

J&L Extruded Sections are Custom-Made for you. They can be preformed to the predominating cross section of the part you wish to produce. And the range of sections is almost limitless. These sections possess the physical benefits and accurate tolerances derived from cold drawing. And you can obtain them in a wide range of analyses.

Use this handy coupon. This new booklet contains detailed information about the money and time saving advantages realized with the use of J&L Extruded Sections.

AT YOUR SERVICE
J&L
EXTRUDED SECTIONS
(HOT EXTRUDED AND COLD DRAWN)
... tailor made to your specifications
1. YOUR section is preformed to the cross section of the part you wish to produce. The range of sections is practically unlimited.
2. YOUR section can be quickly and easily produced. You can obtain it in a comparatively short time. There is less than the normal time lag in the building of dies . . . no necessity to build up inventories.
3. YOUR section is obtainable in a wide range of analyses . . . and, in addition, it will possess the physical benefits and accurate tolerances derived from cold drawing.
practical.
J&L STEEL

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STEEL CORPORATION — *Pittsburgh*

J&L STEEL

Jones & Laughlin Steel Corporation
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Pittsburgh 30, Pa.

Please send me your new Booklet on EXTRUDED SECTIONS.

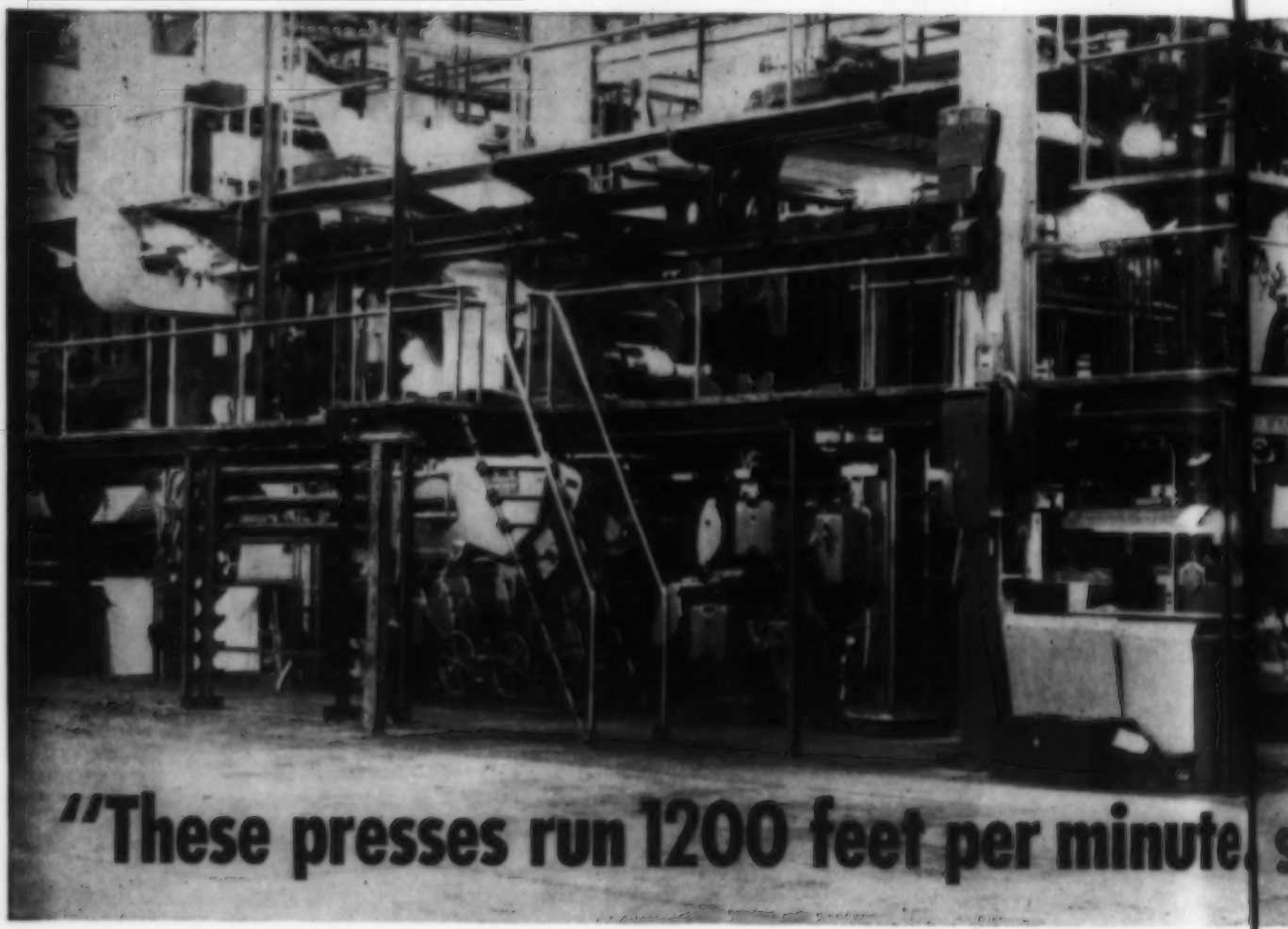
Name_____

Title_____

Company_____

Street_____

City_____ Zone_____ State_____



Cutting knife enters the slot visible in these knife assemblies. Springs maintain pressure on the paper during cut.

Here is a giant multicolor magazine press in action.
Paper is cut 640 times per minute.
Press speed: 1200 feet per minute.

so we need springs that can take it"

says Goss Printing Press Company, world's largest manufacturer of newspaper, magazine and rotogravure presses

● 74% of the world's daily newspapers are printed on Goss equipment. Some of the presses are nearly a city block long—giant, roaring machines that gobble up newsprint at the rate of 1200 to 2000 feet per minute. Many of the largest magazines also are printed on Goss presses, which run up to 1200 feet per minute.

At one end of the press is the cutting cylinder, where the paper is cut "on the run." 640 times a minute, the sharp steel knife snaps in and out between two spring loaded fibre "cushions" that hold the paper against the cutting cylinder. When the knife retracts, the springs push the cushions back out of the way.

According to Mr. William Zimmer, Asst. Chief Engineer, "Inferior springs would fail, jam the cutting cylinders, wedge the folding mechanism, and cause severe damage. I don't think that a spring could have a tougher job; but we've been using American Quality Springs for 20 years with excellent results."

American Quality Springs are available in any size, any quantity, any steel, style or finish—including flat wire and special shapes. Just get in touch with your American Steel & Wire representative.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS American Quality Springs USS

UNITED STATES STEEL

How to make 3 clutch plates do the work of 8

A leading appliance manufacturer modified the transmission in his automatic washing machine to make use of cork-faced clutch plates.

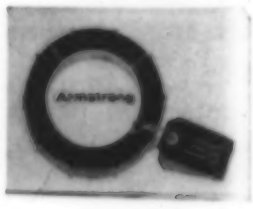
The result? A lighter, simpler, less costly transmission—with the required torque now being delivered by three cork facings in place of eight other plates called for by the original design.

Cork makes design economies like this possible because of its inherently high torque capacity. Cork, in fact, retains a higher coefficient of friction when immersed in the oil of a wet clutch than any other friction material. Because of this, cork will transmit a given amount of torque with fewer or smaller plates —or lower engagement pressures. This permits the use of smaller, less complex hydraulic systems.

Cork helps reduce costs in other ways, too. First of all, it costs less than most friction materials. And there's no need for surface or finish grinding when you use cork facings. They're resilient and mate perfectly with their opposing plates.

Most important, cork is a *dependable* facing material. A cork facing in a properly designed wet clutch will last the life of an appliance or automobile. There's virtually no wear in normal service—and no abrasive particles to contaminate oil and damage gears.

For the whole story on cork friction materials, send for a copy of "Armstrong Resilient Friction Materials." Write Armstrong Cork Company, Industrial Division, 7212 Dean St., Lancaster, Pa.

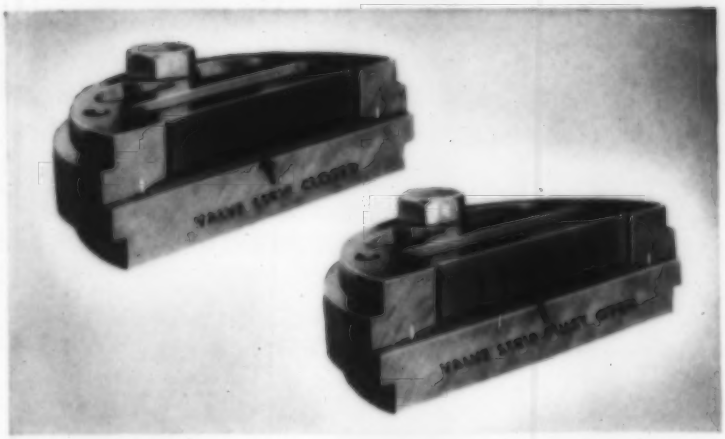


Armstrong FRICTION MATERIALS

. . . used wherever performance counts

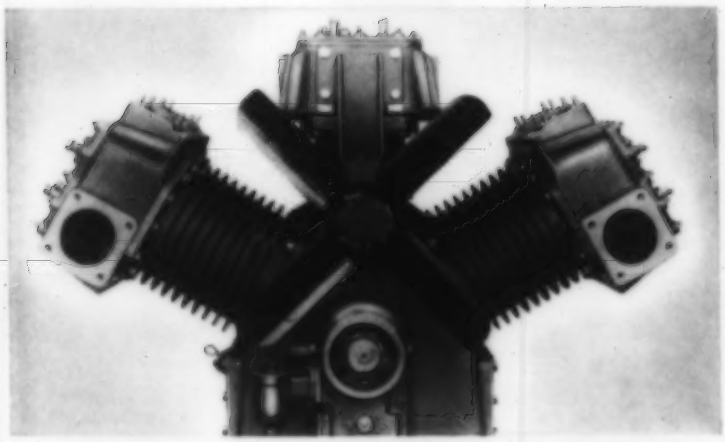
WHAT'S YOUR C.Q.*?

*COMPRESSOR QUOTIENT



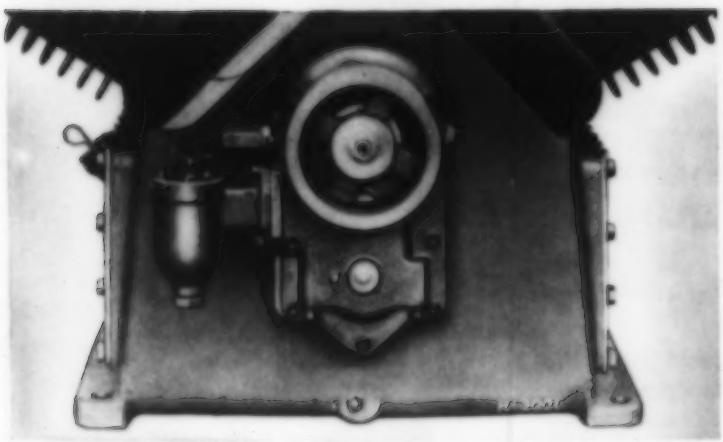
What's the lightest-acting air compressor valve made?

No doubt about this one — it's Worthington's exclusive Feather* Valve. Responsive as a feather to air flow, it can open, release air and close in one-hundredth of a second—with no back-leaking and efficiency losses. You can get more information about the Feather Valve by writing for Bulletin L-675 S12.



How can you get effective air cooling of air compressors?

Fan-cooling of isolated cylinders is the answer. In Worthington Radial and Balanced Angle air compressors, cooling air flows completely around the isolated cylinders. And the high-capacity fan blows air directly over upper parts of cylinders and cylinder heads — where heat is greatest. Our Bulletin H-630-B1 tells you more about Worthington Radial air-cooled air compressors.



What's the modern way to lubricate an air compressor?

The right answer is force-feed lubrication—with continuous full-flow oil filtration. And that's exactly what you get in Worthington Radial Air Compressors (and *only* Worthington, by the way). Result: less bearing wear, less oil pumping, longer cylinder life and lower lubricating oil cost. One twist of the handle cleans the Cuno filter without stopping flow. Read Bulletin H-630-B1 for more facts. PC.5.3

*Reg. U.S. Pat. Off.

Write today for bulletins to Worthington Corporation, Section PC.5.3, Harrison, N.J.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Air Compressors • Pumps • Multi-V-Drives • Allspeed Drives

AT MACH 1+

JACK & HEINTZ
MODEL 50127-000
CONTROL PANEL

PHOTOS COURTESY OF
CONVAIR AND JACK & HEINTZ.

ALL-ANGL Barry Mounts give sure protection

Jack & Heintz proved this in testing mounts to protect their Hi-Phase voltage regulators and control panels for Convair's supersonic F-102A interceptor.

No other miniature isolator tested could meet Procedure I of MIL-E-5272A. ALL-ANGL Barry mounts exceeded life-test requirements.

And the ALL-ANGL works in any position— to give sure protection for vital controls through every twist, turn, and dive in the aircraft's most violent maneuvers.

Write for Data Sheet J-11. And for your airborne requirements to meet standard MIL specifications, ask about All-Metl, Air-damped, and special Barry mounts.

Miniature All-Angl
Barry Mount

Here's the mount that meets the new needs of today's jet aircraft and missiles — where equipment must have greater protection against shock and high-frequency vibrations — and where MIL-standard mounts prove inadequate.

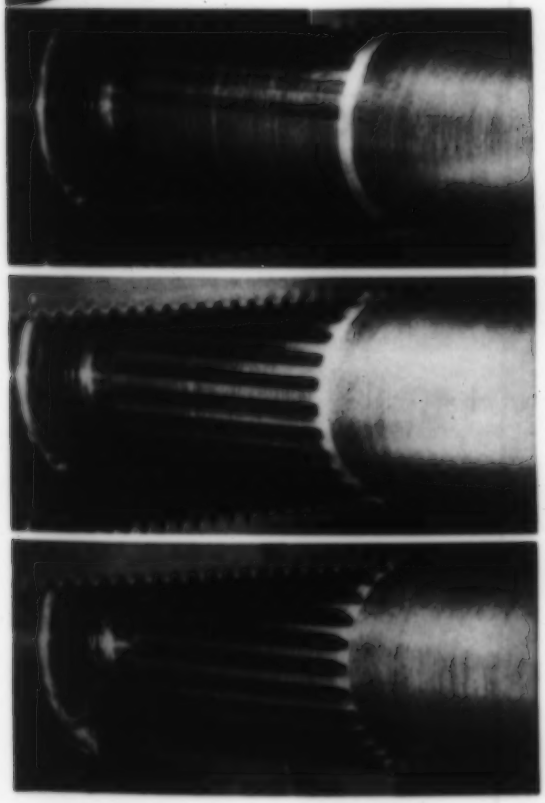
BARRY CONTROLS incorporated 722 Pleasant St. Watertown 72, Mass.

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

7 Reasons Why . . .

1. Accuracy ✓
2. Lower cost ✓
3. Increased strength ✓
4. Smoother tooth surfaces
5. Increased tooth contact
6. Ease of assembly
7. Impossible designs made possible
STANDARDS for Roto-Flo formed splines are being compiled and will be published soon. To reserve your copy—ask for Bulletin SRF-55. Also request Bulletin RF-55 on the Roto-Flo process and machines.

. . . designers are SPECIFYING toothed parts formed by ROTO-FLO



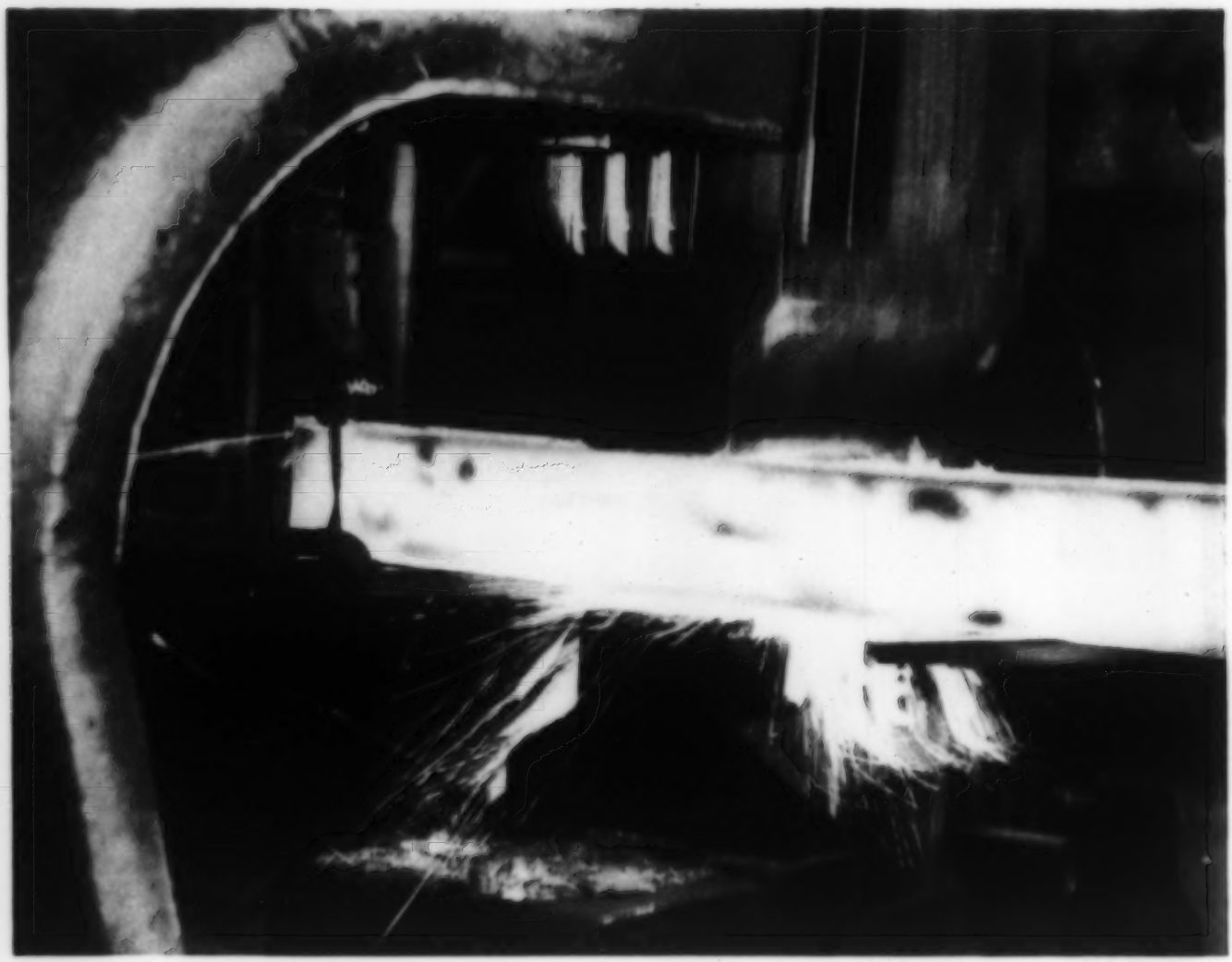
For these 7 good reasons: Automotive, aircraft, appliance, tractor, truck, outboard motor, construction machinery and road maintenance machinery designers are specifying straight, helical or taper splines and other tooth forms that are formed on the new Roto-Flo spline rollers.

An example: One designer specified a spline in the middle of a shaft, with adjacent bearing surfaces on both sides, and splines on each end of the same shaft. The three splines are accurately cold formed one after the other on three automated Roto-Flo spline rollers—with only one machine operator in attendance. Production is 300 parts per hour.

MICHIGAN TOOL Company

7171 E. McNICHOLS RD • DETROIT 12, MICHIGAN, U. S. A.

This is how splines and similar toothed parts are cold formed on the ROTO-FLO spline roller—blank to finished spline in 4 seconds, total automatic cycle: 11 seconds.



From Vacuum Melting – improved alloys with exceptional properties

...*higher* IMPACT RESISTANCE, *for example*

Here's another important advantage of vacuum-melted alloys – *substantially higher impact resistance* . . . over 25 times greater, for example, in one grade of stainless steel.

Tensile strength, stress rupture strength at elevated temperatures, fatigue life, ductility, uniformity, and fabricating characteristics are improved, too, by vacuum-melting.

Here's why . . . *Vacuum-melting literally sucks gaseous impurities from the molten metal . . . removes inclusions and gases that limit the performance of conventional air-melted alloys. That means purer metals that are stronger, tougher . . . closer to their theoretical limits of properties.*

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted metals, now can promptly supply them in tool, high-speed, stainless, and alloy steels – in most sizes and grades – as well as special ferrous and nonferrous alloys. For help with metal problems that vacuum-melted alloys might solve, please write us, describing them in as much detail as possible. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

VMC

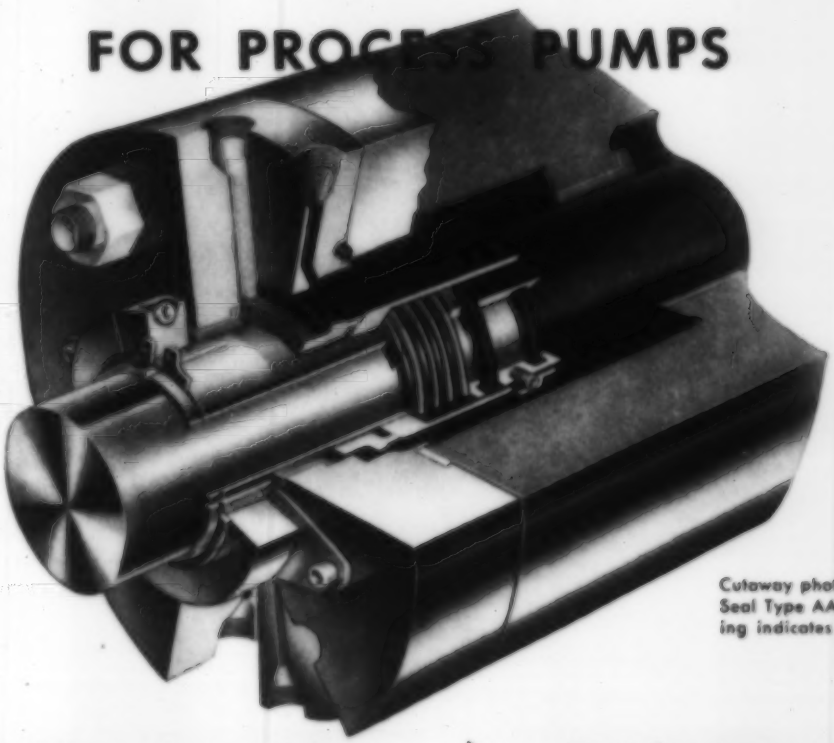
VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

NEW from GARLOCK...

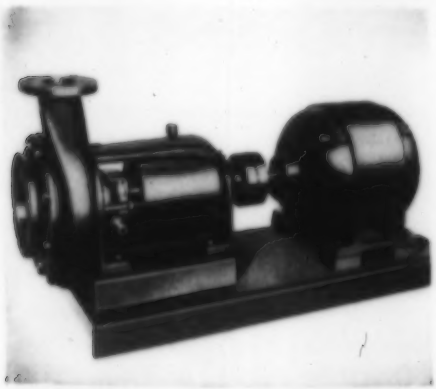
MECHANIPAK* SEALS

FOR PROCESS PUMPS



Cutaway photo of Garlock Unitary Seal Type AA51B-23. Yellow shading indicates liquid being sealed.

- One Piece Assembly
- Quick, easy installation
- Pre-set at factory
- Maintenance-free life



Typical chemical pump for which Garlock Unitary Seals are designed.

SAVE installation time, eliminate maintenance costs with Garlock's new Unitary Mechanipak Seals for process pumps!

The entire unit, including sleeve and gland, is furnished completely assembled. The seal is pre-set at the factory—no on-the-job adjustments are needed. The *external* lock and drive is readily accessible—eliminates set-screw drive.

Get all the facts today! Phone your Garlock representative or write for new Folder AD-151.

The Garlock Packing Company, Palmyra, New York

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N. Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

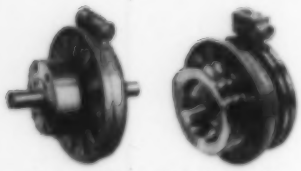
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

*Registered Trademark

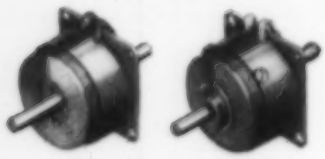
21 WAYS WARNER ELECTRIC BRAKES MACHINE DRIVES, IMPROVE

MAJOR IMPROVEMENTS in performance of machinery are now being made without major redesign or expense through the application of Warner Electric Motion Control. The reason is the armature and magnet assemblies of Warner Electric Brakes, Clutches, and Clutch-Brakes can easily be installed by a variety of methods to suit space requirements and the existing design of machinery.



Electric Brakes, Clutches, and Clutch-Brakes

Five standard sizes ranging from 40 to 700 lb-ft, maximum static torque rating. Energized by 25-35 watts of 6 or 90 v d-c.



Small "SF" and "RF" Line

Three sizes ranging from 8 to 240 lb-in, maximum static torque rating. Energized by 6 to 9 watts of d-c.

Large "SF" and "RF" Line

Four sizes ranging from 125 to 700 lb-ft, maximum static torque rating. Energized by 25-35 watts of d-c.

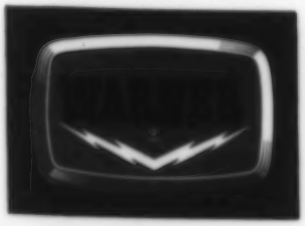
With the exception of certain tolerances, practically the only limitation to the way unit assemblies can be arranged is that the armature and magnet surfaces be in contact. Magnet assemblies can be mounted from the *inside* or *outside* by a flange. Armature drive pins can be mounted directly to a drive sheave, sprocket, gear, or other moving part . . . or back-to-back with the armature of another Warner unit. Gear-type hubs permit mounting the armature to a split shaft for clutch-coupling or clutch-brake coupling applications. Clutches and brakes may be mounted together for fast, accurate stop-start control. Individual units mounted at different points on the machine give you the same precise operating characteristics.

Electro-magnetic control of lineal and rotary motions is an important "break through" for automation minded machine designers. For, now electrical devices such as limit switches, relays, electric eyes, electronic controls, etc. can be used to make machines more articulate and automatic. If you have a stopping, starting, inching and jogging, lineal positioning, rotary indexing, interlocking, or tension control problem, send for a copy of this new application analysis report, which illustrates methods of installation and design principles which have successfully solved difficult machine design problems, increased production, reduced manufacturing costs, and added new sales features to machinery.

DESCRIBES 6 EXCLUSIVE ENGINEERING FEATURES THAT MAKE YOUR MACHINES MORE SALEABLE. These include: (1) faster and smoother starts and stops—no translation time during engagement of armature and magnet; (2) minimum shock to gear trains and machinery—progressive torque build-up absorbs backlash and windup in gear trains and shafts; (3) no adjustment needed—no bands, links, cams, or adjusting screws; (4) infinite control of torque—rheostat control permits stepless adjustment of acceleration and deceleration; (5) minimum shaft space required—elimination of sliding yokes and jaw-type engagements saves space; (6) rapid heat dissipation—segmented armature dissipates heat and fluted backing plate gives cooling action.

AND CLUTCHES ARE USED TO MODERNIZE CONTROL, AND MAKE YOU MORE COMPETITIVE!

SHOWS HOW EASILY ELECTRIC BRAKES AND CLUTCHES FIT INTO STANDARD POWER TRANSMISSION DRIVES. Applications are analyzed in agricultural machinery, machine tools, welding equipment, packaging machinery, textile machines, molding equipment, and printing equipment.



Beat competition with

ELECTRIC BRAKES AND CLUTCHES

Warner Electric Brake & Clutch Co. • Beloit, Wisconsin

Warner Electric Brake & Clutch Co.
Dept. MD Beloit, Wisconsin

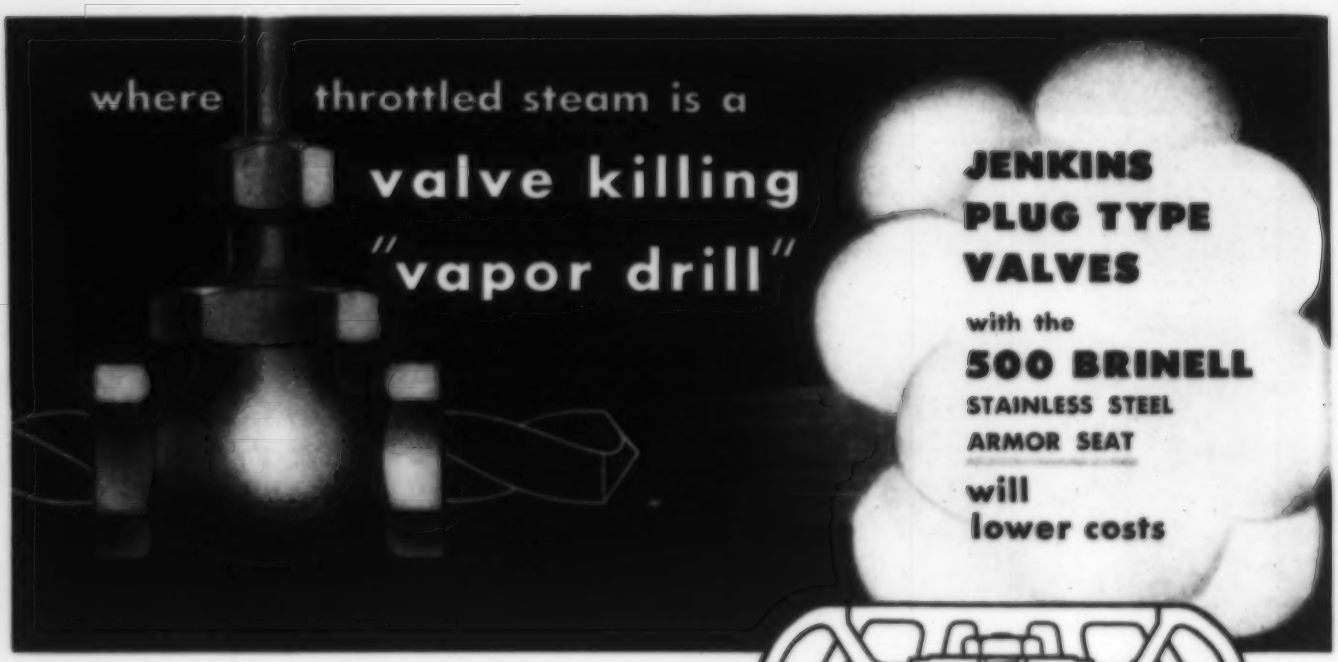
Please rush my copy of your Application Analysis Report so I can see how easy it is to design standard Warner units into power transmission drives.

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____



JENKINS PLUG TYPE VALVES
with the
500 BRINELL
STAINLESS STEEL ARMOR SEAT
will
lower costs

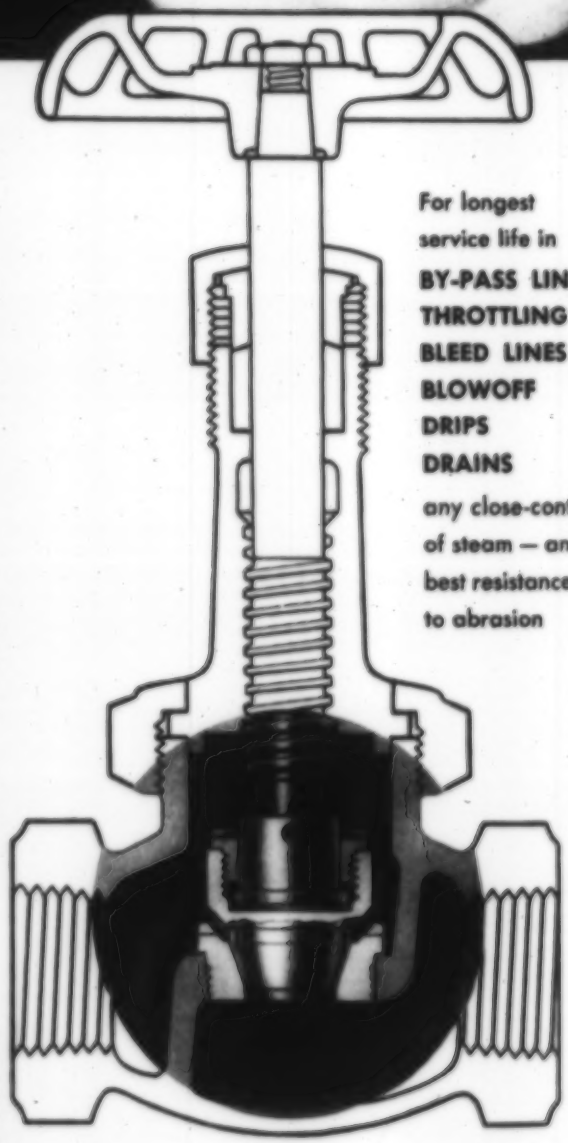
Closely regulated steam erodes grooves in seating units and drastically cuts service life of ordinary valves.

Jenkins Plug Type Valves have been engineered in every detail for maximum wear in such valve-killing service. The stainless steel Armor Seat defies the "vapor drill", and Jenkins quality throughout gives them top rating for wear-proof and trouble-proof perfomance.

Make you own test . . . in your toughest steam service . . . or anywhere that abrasion or erosion causes frequent valve failure. Compare, part for part, with any similar valve. You'll find that, again, Jenkins *extra value* pays off in longer life and lower maintenance cost.

Plug and seat ring are Jenkins JX500, a Stainless chromium alloy steel made to Jenkins high strength specifications, heat-treated to 500 Brinell. Seating surfaces are super-hard and mirror-smooth, offer highest resistance to galling, cutting, abrasion, and erosion. Wide, steep, 30° total taper permits extremely close regulation of flow and vapor-tight closure.

The Stainless steel plug is securely fastened to the spindle with a bronze locknut. Spindle is aluminum bronze with a tensile strength exceeding 70,000 lbs., — has high corrosion resistance.

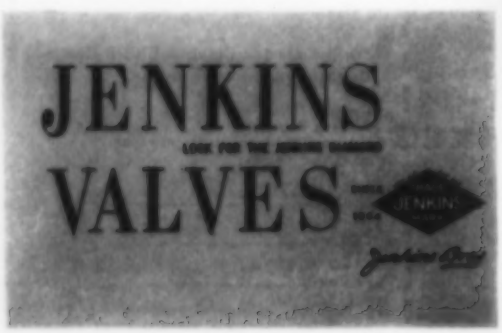


For longest service life in
BY-PASS LINES
THROTTLING
BLEED LINES
BLOWOFF
DRIPS
DRAINS
any close-control of steam — and for best resistance to abrasion

300 lb. 200 lb. 150 lb.
GLOBE and ANGLE

For complete information call your Jenkins Distributor — ask for Form 202. Or write: Jenkins Bros., 100 Park Ave., New York 17.

SOLD THROUGH PLUMBING-HEATING AND INDUSTRIAL DISTRIBUTORS



DOW CORNING CORPORATION

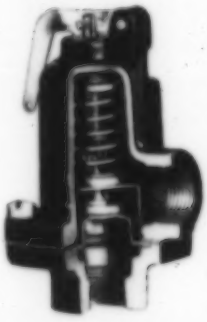
Silicone News

FOR DESIGN ENGINEERS

Dependable Valve Operation Assured With Silastic Seals

Relief valves for hot water must: open accurately at set pressure; close, drip-tight, at the slightest reduction from that pressure; give long reliable service. That's a difficult order but with heat-stable Silastic*, McDonnell & Miller, Inc. of Chicago have engineered such maximum dependablity into their new No. 230 series of pressure relief valves.

Because it has excellent resistance to moisture and to compression set at high temperatures, Silastic is ideal for sealing these devices. In the words of McDonnell & Miller, "the compressibility of Silastic provides good closure, its high temperature stability guards against deterioration, and Silastic resists adhesion, thus providing dependable operation." *No. 59*



1955 CHEMICAL ENGINEERING AWARD WON BY DOW CORNING CORPORATION

New York—An 84-man committee of senior chemical engineering educators, headed by Professor Walter G. Whitman, director of the chemical engineering department, Massachusetts Institute of Technology, has selected Dow Corning Corporation winner of the 1955 Award for Chemical Engineering Achievement sponsored by Chemical Engineering magazine.

Silicone products most widely used, are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design engineers. *No. 62*

Silicone Insulation Eliminates Need For TEFC Motors in Tidelands Oil Operations; Saves $3,000 per Unit

In the dark ages before silicone insulation was developed, it was standard practice to specify TEFC motors in outdoor installations where excessive moisture, weathering or corrosive chemicals limit service life. Now progressive engineers are finding that open-type motors insulated with Dow Corning Silicones are equally effective and substantially less expensive.

A typical example of good modern practice is the silicone insulated compressor motor operating on one of the California Company's fixed oil well platforms in the Gulf of Mexico. Built by Electric Machinery Mfg. Co., Minneapolis, this 300 hp, 900 rpm induction motor is exposed to the most severe weather the Gulf can produce. Installed 10 months ago, the unit is in excellent operating condition.

The windings of this "Sil-Clad" motor are insulated with Dow Corning silicone resins, silicone resin-impregnated components, and a tape made with Silastic*, Dow Corning's silicone rubber. Outer protection is provided by a steel housing with a baffled ventilating system that prevents dust, moisture and chemicals from lodging in the motor. The housing and motor frame are coated inside and out with a silicone based paint formulated by Midland Industrial Finishes Co.

According to Electric Machinery, this "Sil-Clad" motor is more reliable and more resistant to corrosion than conventional Class A or B totally enclosed, fan cooled motors of the same rating. And it cost $3000 less than a comparable TEFC motor built with ordinary insulating materials. Lower initial costs combined with greater reliability and lower maintenance costs account for the rapidly increasing market for such motors. *No. 60*

*T.M. REG. U.S. PAT. OFF.

New Silicone-Glass Insulators Meet Class H Specifications, Are Stronger, Easier to Use

Production methods developed by Silicone Insulation, Inc., New York City, reduce the cost of molding one-piece silicone-glass laminated coil bobbins and other Class H components. Users save assembly costs.

In the bobbins, glass cloth impregnated with Dow Corning 2104 silicone resin flares out from the cores into flanges providing completely unified structures that are easy to handle for quick assembly, and exceptionally strong in proportion to their wall thickness. Tolerances may be held as low as ± .001".

Neither brittle nor flexible, these one-piece laminated Class H bobbins show no tendency to break at the joints, crumble or delaminate. Already in use by several leading manufacturers of high temperature transformers, relays, solenoids and controls, they are available in a wide range of sizes and dimensions, and may have as many as six integral flanges.

Price-wise, silicone-glass laminated bobbins compare favorably with conventional Class H assemblies. Low mold costs permit production runs of as few as one hundred parts. *No. 61*

Design Edition '55

DOW CORNING CORPORATION - Dept. 6812
Midland, Michigan

Please send me 59 60 61 62

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COMPANY _____

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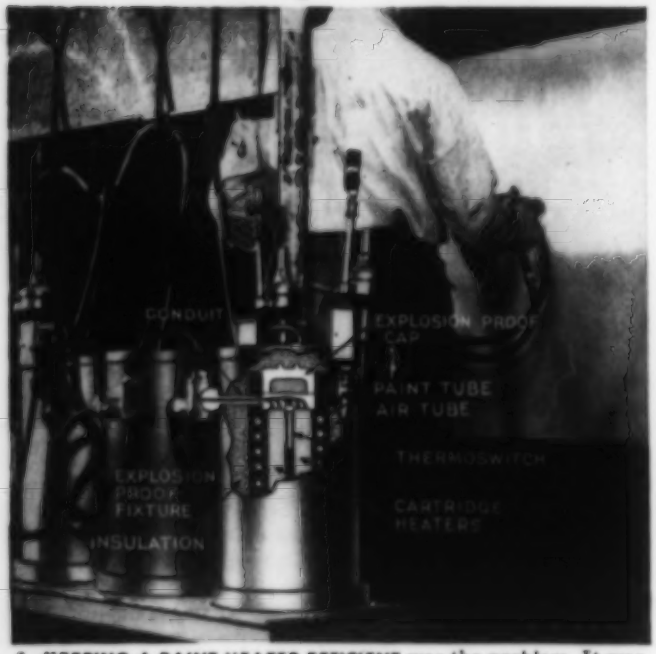
CITY _____ ZONE _____ STATE _____

ATLANTA • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)

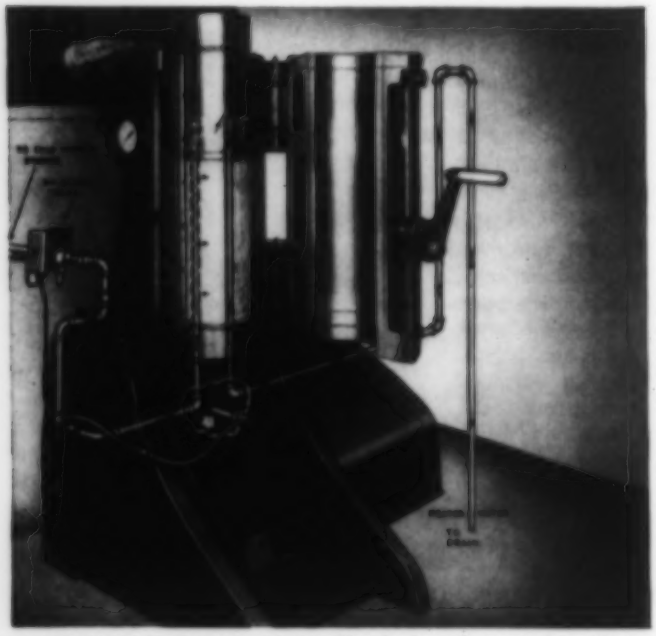
Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

How would you solve these tricky temperature control problems?



1. KEEPING A PAINT HEATER EFFICIENT was the problem. It was solved with the help of a Fenwal heavy duty block THERMOSWITCH® unit. Heat from a 2000-watt source is accurately held at 150F—for top efficiency. Users just plug it in, forget it. THERMOSWITCH unit is attached to explosion-proof block, as shown in diagram.

2. PROTECTING MACHINERY. Engineers wanted to prevent motor damage to automatic brush assembly equipment by starting the operation shortly *before* the sealing compound (pitch) reached the liquid stage. Upon Fenwal advice an inverse type THERMOSWITCH unit was installed to close circuit when pitch temperature reaches 180F. Circuit opens *only should* pitch heaters fail.



3. COOLING PRINTING PLATES. If printing plates cool too fast, they shrink — if too slow, they become porous. Reject plates were practically eliminated when a solenoid water valve was substituted for a hand valve — with a Fenwal THERMOSWITCH unit guarding the water temperature closely and operating the valve whenever the set point was passed. THERMOSWITCH shell itself "senses" change.

4. FREE CATALOG brings you complete data on the unique THERMOSWITCH unit. More details on problems discussed here if you want them. Fenwal engineers are always glad to help on special temperature control problems involving heat, humidity, pressure and other variables. Write **Fenwal Incorporated, 1912 Pleasant St., Ashland, Mass.**

Fenwal **THERMOSWITCH®**

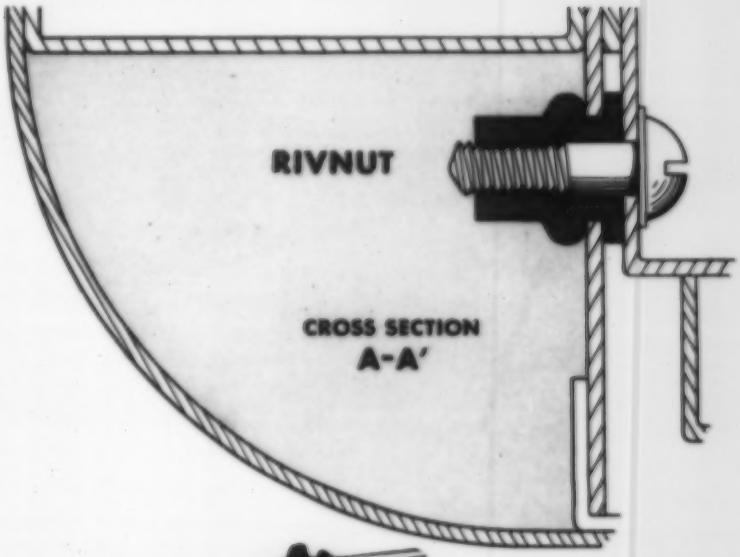
Controls Temperature — Precisely

B.F. Goodrich Rivnut

provides blind shockproof nutplate, clean for attachment – in seconds!

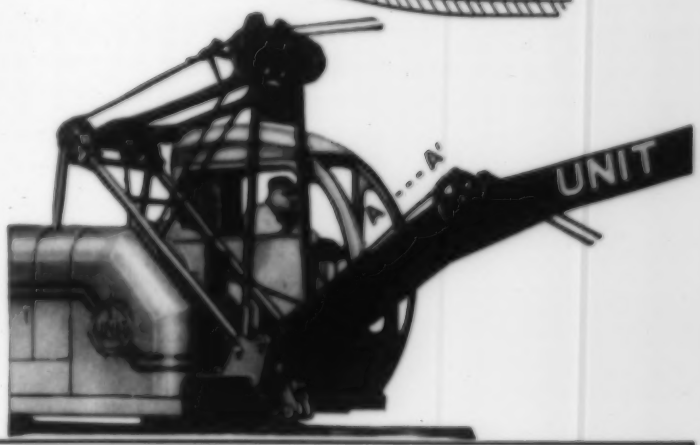
B. F. Goodrich Rivnuts provide firm, accurate nutplates in one, quick operation. They are particularly suited for blind applications where other methods of fastening are impossible. And they form shockproof nutplates that hold secure against all kinds of vibration.

B. F. Goodrich Rivnuts cut assembly time and costs, eliminate nuts, welding, tapping, clinching. They provide a tight, dependable seal. Save man-hours, too, because one operator can install a Rivnut in seconds! If you're looking for a fastener that can improve your product and cut production time, why not get the help of BFG Rivnut engineers. *The B. F. Goodrich Co., Tire and Equipment Division, Rivnut Sales, Akron, Ohio.*



Rivnuts make new cab design possible

"Our entirely new cab design would not have been practical without the Rivnut," says Unit Crane & Shovel Corporation. Rivnuts solved three big problems in this design: 1) gave Unit Crane a blind nutplate; 2) in metal too thin for tapping and welding; 3) that would hold secure against vibration.



How Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2 Rivnut is inserted—head firmly against work—tool at right angles to work.

3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

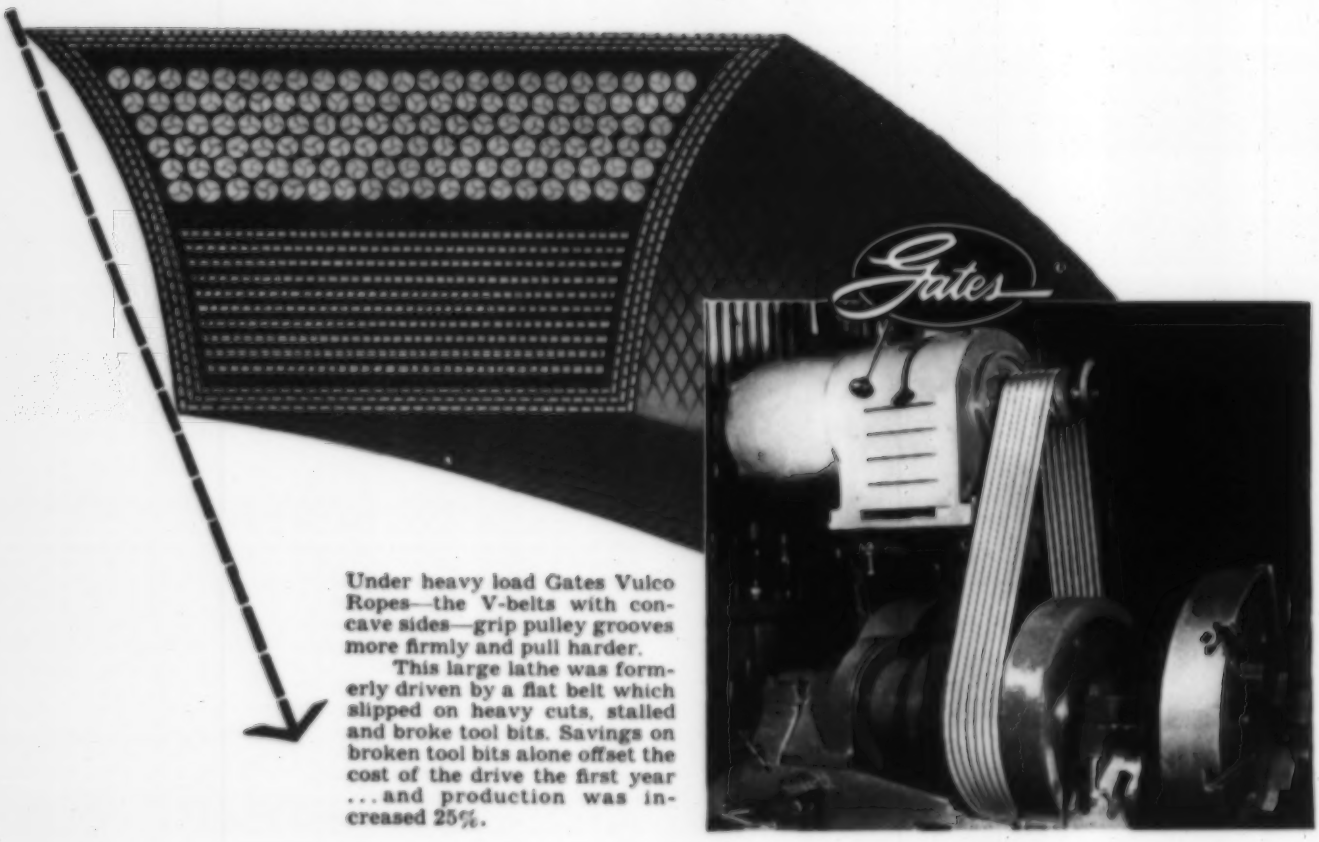
4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

B.F. Goodrich RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and WITH. Explains construction, simplicity of installation. Get your free copy by writing to: The B. F. Goodrich Co., MD-125, Akron, O.



Under heavy load Gates Vulco Ropes—the V-belts with concave sides—grip pulley grooves more firmly and pull harder.

This large lathe was formerly driven by a flat belt which slipped on heavy cuts, stalled and broke tool bits. Savings on broken tool bits alone offset the cost of the drive the first year ...and production was increased 25%.

Concave sides keep belt costs down!

Industry is saving thousands and thousands of dollars every year by specifying Gates Vulco Ropes—the V-Belts with *concave sides* (U.S. Pat. No. 1813698).

Here's the interesting reason *why* Gates belts save money:

On the bend around the sheave the *precisely engineered* concave sides (Fig. 1) of the Gates belt fill out and become straight (Fig. 1-A). Thus the belt makes uniform contact with the sides of the pulley. That means sure pulling power and *even distribution of wear*. Longer wear, fewer replacements cut belt costs...reduce down time...contribute to profits.

Simple test proves value of concave sides

Bend a straight-sided belt (Fig. 2) and feel the sides *bulge out* around the bend. The bulging sides prevent the belt from fitting evenly in the pulley groove (Fig. 2-A). Uneven contact causes uneven wear...shortens belt life...increases costs.

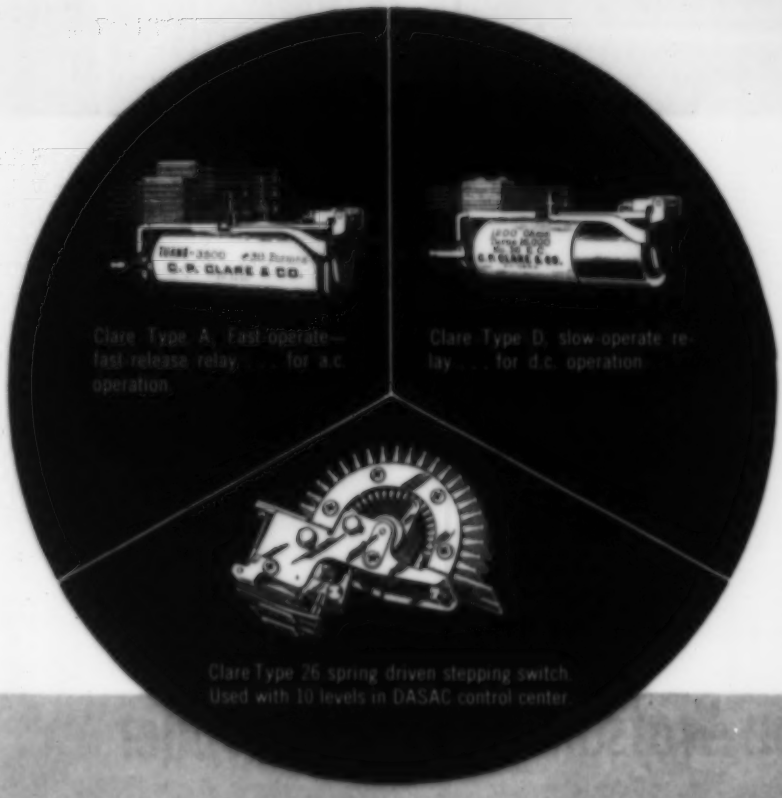
Keep belt costs *down* by specifying Gates Vulco Rope Drives—the V-Belt with *concave sides*. Belts you need are readily available from nearby distributor stocks. The Gates Rubber Company, Denver, Colorado—*World's Largest Maker of V-Belts.*

Gates Engineering Offices and Distributor Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TPA 25-A

GATES VULCO ROPE DRIVES

Stability and Reliability make CLARE Relays and Stepping Switches ideal components for DASAC



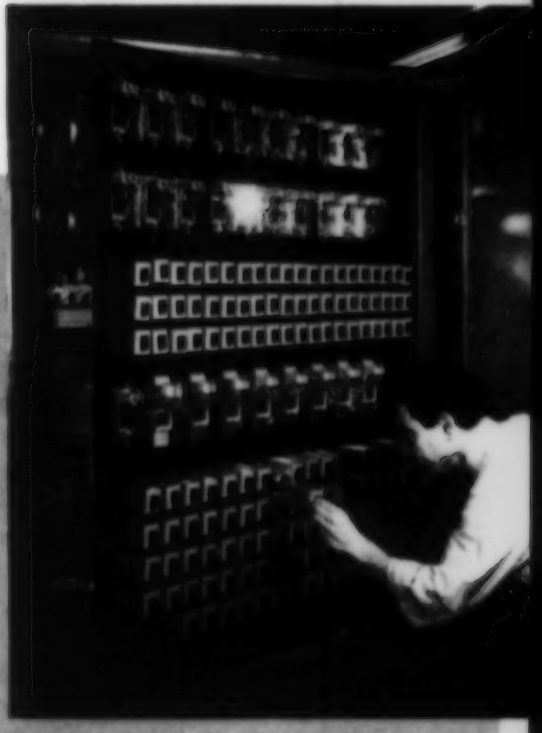
Clare Type A, Fast operate—fast release relay . . . for a.c. operation.

Clare Type D, slow operate relay . . . for d.c. operation.

Clare Type 26 spring driven stepping switch. Used with 10 levels in DASAC control center.

DASAC Push Button Control Center which uses Clare relays and stepping switches in automatic control of warehouse assorting system.

Rear view of panel shows Clare relays, provided with dust tight covers, accessible for quick inspection and maintenance.



Pushbutton control center of the DASAC warehousing and assorting system makes use of over a hundred CLARE Type A and D relays and CLARE 10 level, 26 point stepping switches.

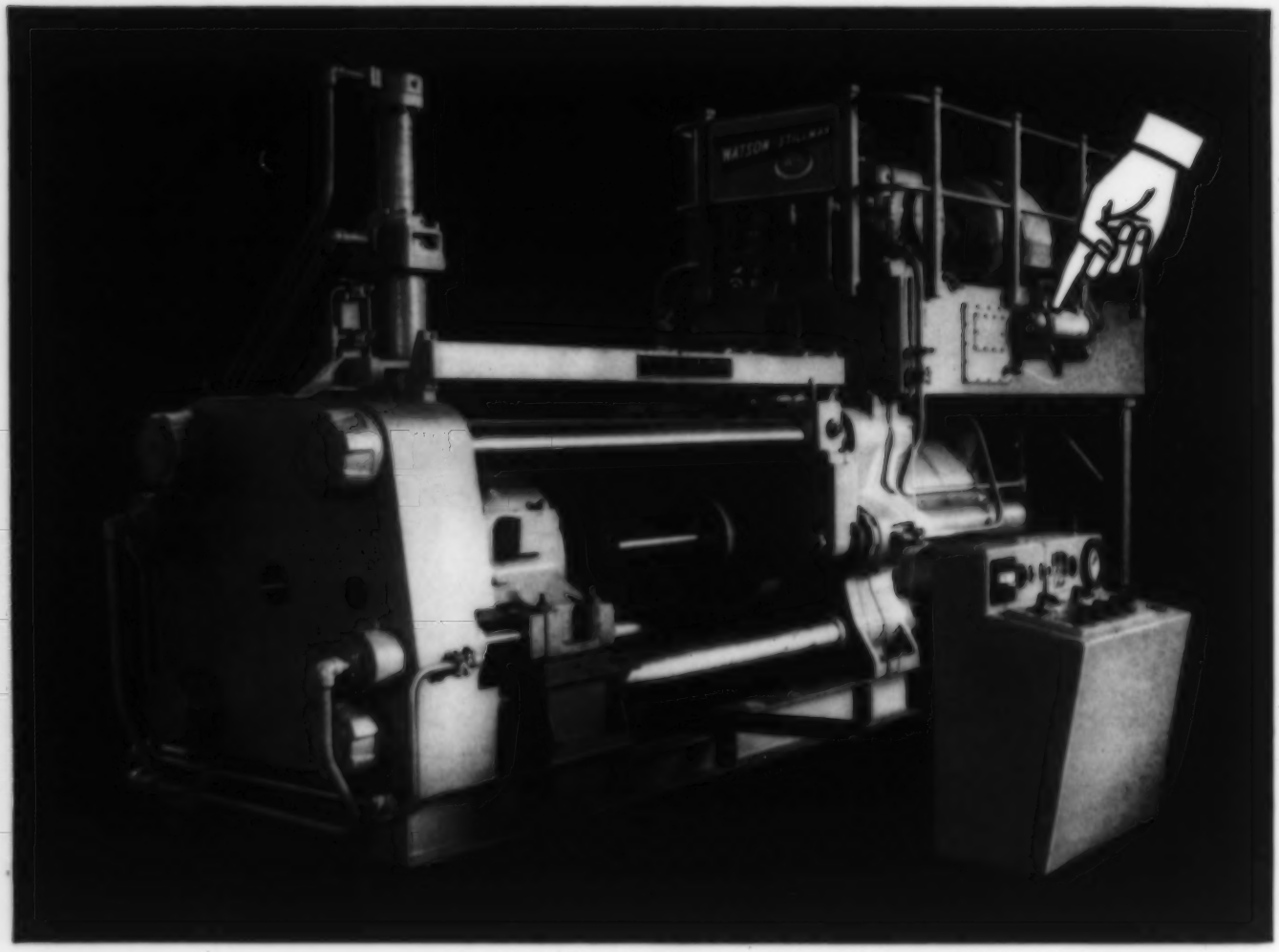
This device, which speeds and simplifies order picking operations, was developed by New York's Dasol Corporation, consulting engineers, to facilitate the warehouse operations of their client, Judy Bond, Inc., large blouse manufacturer.

The DASAC Control Center performs three basic functions. These include selection of container destination, "memorizing" the selections in consecutive order and coordinating the information to stop the container at its proper discharge point. "Relay requirements," said Sol Tanne, Dasol Chief Engineer, "above all, demanded stability and reliability. They had to be fast-acting, quiet, stable telephone-type relays which could easily be replaced if necessary."

Ability of CLARE Relays to perform millions—in some cases billions—of trouble-free operations has made them increasingly in demand as reliable components for today's high speed devices. If your design calls for long-life, high-quality relays or stepping switches, it will pay you to bring your problem to CLARE. Experienced field engineers are located near you. Contact them or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field



ROSS EXCHANGER insures full hydraulic power of this 1250-ton Watson-Stillman Extruder

With an advance speed of 440 ipm, an extrusion speed of 29 ipm and a return speed of 670 ipm, this 1250-ton Watson-Stillman Aluminum Extrusion Press has been equipped to handle billets up to 5⅛" x 24".

To maintain the full 108 gpm capacity of this extruder's multiple piston type pump, a Ross Type BCF Exchanger is furnished here. Compact and accessible, it provides safe, dependable oil cooling at all times.

Assuring the utmost in thermal efficiency and ruggedness, Ross Exchangers are regularly installed on numerous types and makes of metal working equipment: metal drawing presses, die casting machines, welders, as well as engines, compressors, lubrication systems and speed increasers . . . to cool hydraulic fluid, jacket water and lube oil.

Pre-engineered, fully standardized and stocked in a wide range of sizes, they are promptly available to answer *your* needs. Request Bulletin 1.1K5.

KEWANEE-ROSS CORPORATION

DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION

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General Manufacturing Co., Inc.
1957 Plant St.
Middletown, U.S.A.

Att.: Chief Design Engineer

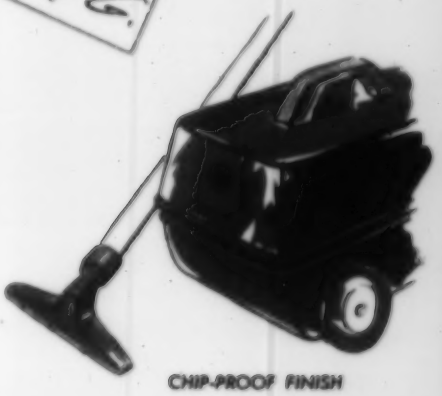
Dear Sir:

Here's something new...

Now you can have bright anodized aluminum parts that match chrome plate almost exactly for brilliance, color and tone.

CD
This is news!
RL

Or you can have these parts in rich golds, peacock blues, deep crimsons...any color or tone you wish...with lusters from a bright high polish to a soft satin. No chipping. No peeling. Top notch resistance to wear, weather, corrosion.

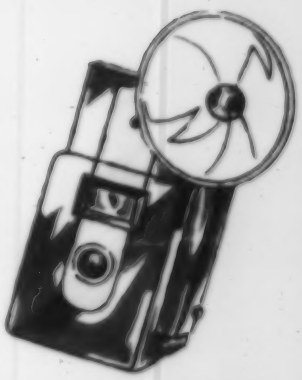


CHIP-PROOF FINISH

You can have any aluminum part bright anodized, whether stamped, forged, drawn, or extruded.

Already designers are seizing the idea...

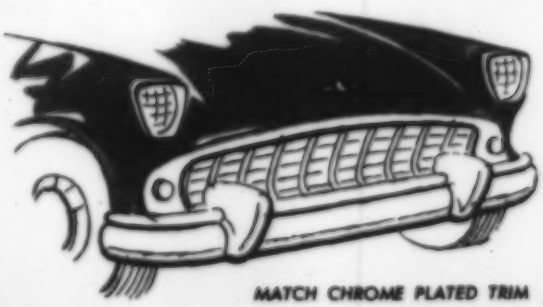
For instance, gay frames for eyeglasses are now bright anodized. So are exciting new coffee makers...and a number of colorful houseware items.



ACID RESISTANT AND NON-FADING

That's only the beginning. Bright anodized aluminum is replacing heavy chrome plated grilles in several style-setting new automobile models now in production or planned. The blend with chromed body trim and bumpers is said to be perfect...cost and front-end weight much lower.

Maybe this will answer that problem we discussed at lunch yesterday.



MATCH CHROME PLATED TRIM

BLEND WITH INTERIOR UPHOLSTERY

In the appliance field, one leading range maker is bright anodizing control knobs and emblems. And bright anodizing is also being used to re-style refrigerator and other kitchen appliance hardware...in color.

So it goes. Think what might be done to give dash boards new dash! And maybe we'll soon see a car "gold-trimmed" throughout. We've sketched other possibilities and you'll think of more -- instrument bezels, tubular furniture, window frames, perhaps. TV sets? Cameras?

Lets take a new look at our whole line

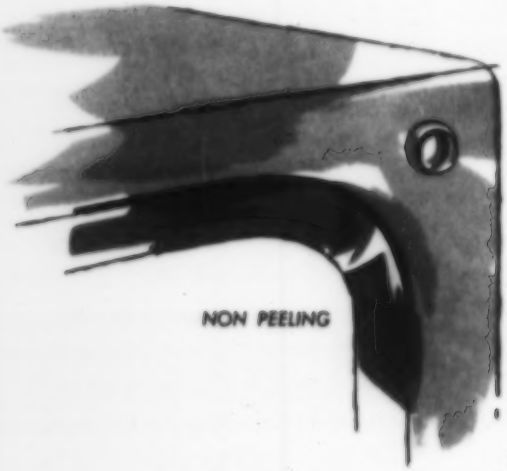
And your products? Doehler-Jarvis is ready to stamp, forge, extrude, or draw aluminum parts and bright anodize them for you. Maybe, too, we can give an "assist" on design.

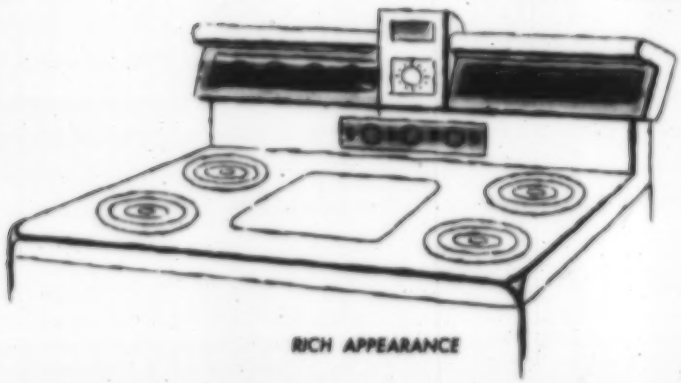
A Doehler-Jarvis sales engineer will be glad to meet with you anytime. Just say the word.

Sincerely,

Doehler-Jarvis Division
National Lead Company

I'll be in Chicago this week. See if you can set something up for the week following.
R.T.





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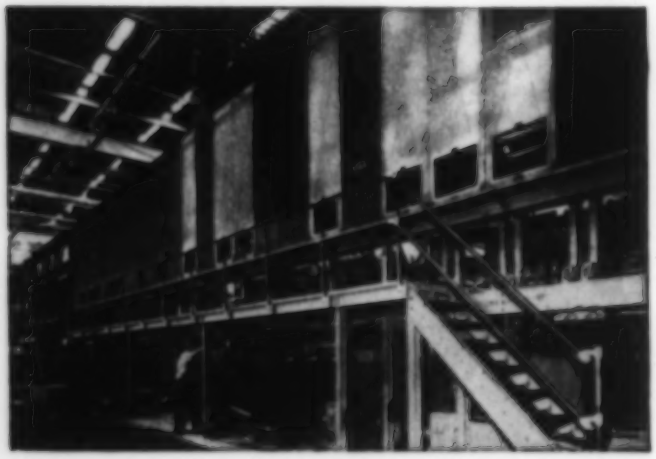
TOLEDO 1, OHIO

What's Your Problem?
Rub your Aladdin's Lamp and Potter & Brumfield's twentieth century "Genie" will give you the right answer.
Let him become a member of your design engineering group. Avoid costly delays in arriving at the most economical solution to your circuitry problems.
Potter & Brumfield has the personnel for design and test of most types of components as well as the facilities to manufacture them.
Send your specifications for recommendations and quotations.
For quick delivery over 350 different standard relays stocked by 500 Franchised Electronics Parts Distributors throughout the United States and Canada.
Potter & Brumfield
PRINCETON, INDIANA
SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY
RELAYS · ALL SIZES · ALL TYPES · FOR ALL APPLICATIONS

"No breakdown in 14

says

Ajax Electric Salt Bath Furnace, interior view from end. Main roller chain drives lie parallel along furnace bed. Nine separate transfer chain drives (attached to visible sprockets) convey fixture carriers from bath to bath, each at a fixed speed which varies with each step.



(Left) Workman inspects processing baths beneath conveyor system of Ajax Electric Salt Bath Furnace. Nearly a half mile of roller chain drives keeps materials moving with clock-like precision through the various steps of the process.

"Morse gives us excellent results"

"We've worked with Morse Chains for 14 years, and have never experienced a breakdown of this product during that period. And, in our complex installations of electric salt bath furnaces, Morse is giving us excellent results."

Philip W. Attwood

Field Engineer
Ajax Electric Co.,

years with Morse Chain,"

Ajax Electric Company Engineer

Ajax Electric Salt Bath Furnaces point up how roller chain can save you on operating costs, cut your downtime, give you flexible, dependable power.

The Ajax Electric Co., Philadelphia, manufactures custom electric salt bath furnaces, used to temper metals used by the automotive and metalworking industries. These furnaces, which automatically transfer materials through as many as nine separate processes, use roller chain for power transmission.

Alkali cleaner, molten salt, steam—all are used in the process. Each is a potential threat to the more than 2000 feet of roller chain used in one of these Ajax furnace lines.

Operator hangs metal parts to be "martempered" in Ajax furnace line on fixture holder. Chain and sprockets in foreground point out ease of adjustment. By changing sprocket diameter, or addition or removal of links, timing of drive can be altered at any time.

Yet for 14 years, drives like these have performed efficiently and dependably, *with not a single breakdown.* (Read statement on left page.)

Morse Roller Chain instantly adaptable

Ajax furnaces involve timed "dips" of the metal parts to be hardened. These periods will vary. By simply changing the number of links in a chain drive, or the diameter of the sprockets, each step in the process can be speeded up or slowed.

You, too, can get the same type of superior power transmission with Morse Roller Chains. Precision-made in all standard sizes and pitches. A wide variety of standard and special-purpose attachments are available to meet specialized requirements.

Literature, engineering help FREE

Write today for Catalog C51-50, or free consultation on your power transmission problems. Morse has skilled engineers available to help you solve practically any problem involving transmission equipment: Roller Chain, Hy-Vo Chain, Silent Chain, Sprockets, Clutches, and Couplings.

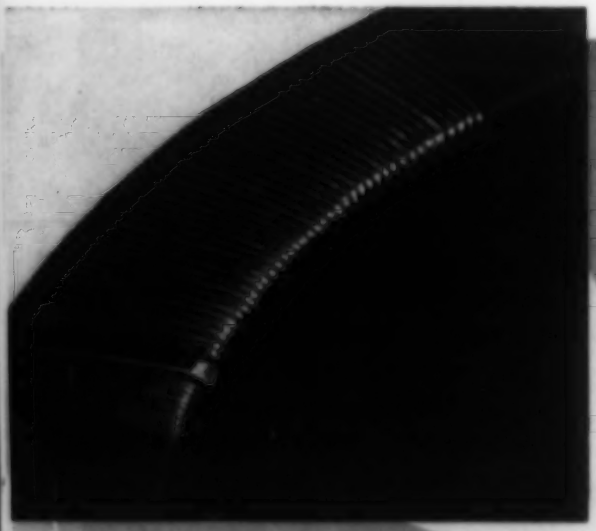
Check these advantages of Morse equipment:

- √ Long service life
- √ Low operating cost
- √ Easy to assemble, disassemble
- √ Requires minimum maintenance
- √ Wide ranges of types and sizes
- √ Precision construction

MORSE CHAIN COMPANY • INDUSTRIAL SALES DIVISION • ITHACA, NEW YORK

MORSE BW **CHAINS, CLUTCHES, AND COUPLINGS**

OHMITE® RHEOSTATS HAVE *Smoother Windings!*

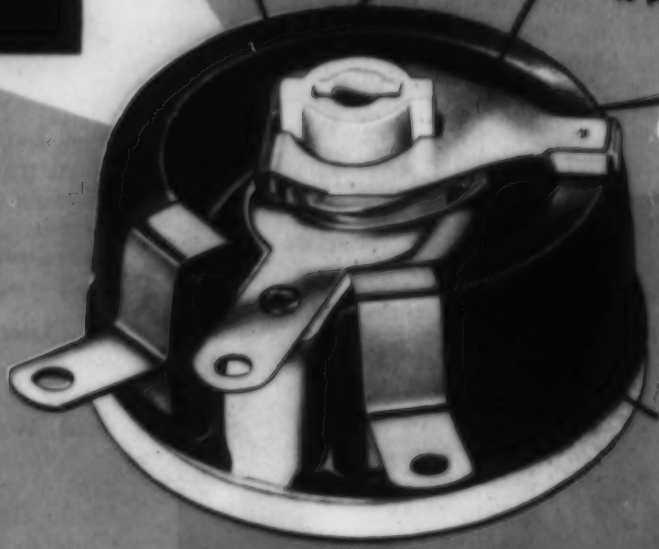


5 REASONS WHY—

1. PRECISION GROUND CORE . . . Cores for fine wire, high resistance units are ground to give a smooth, flat contour for the contact brush.

2. SMOOTH JUNCTIONS where wire sizes change between sections of tapered windings . . . less differential between wire sizes.

3. PERMANENTLY LOCKED WINDINGS . . . Core and windings are bonded together with vitreous enamel to prevent shifting of wire.



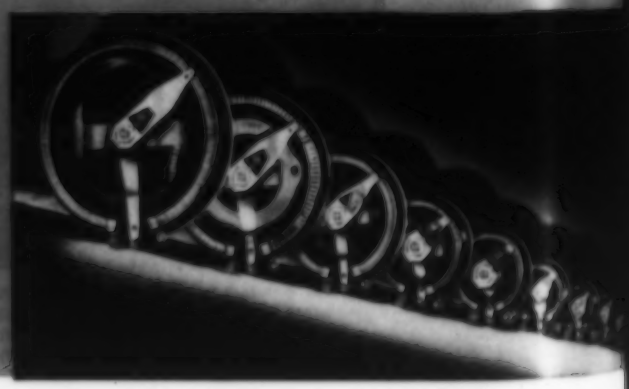
4. UNIFORM WIRE SPACING . . . Ohmite has developed special winding machines to insure uniform spacing and eliminate crossover of adjacent turns on fine wire units.

5. FLUSH TERMINALS . . . Terminals are flush with windings . . . brush glides smoothly from windings to terminal.

See for yourself! Examine an Ohmite Rheostat first hand. Compare its smoother resistance windings. Turn the knob and note how easily and smoothly the contact brush glides over the rheostat windings.

There's less wear on the resistance wire and on the contact brush. The brush makes contact with all of the turns and the resistance varies smoothly and uniformly as the shaft is turned. Every Ohmite Rheostat is *individually tested* on ultrasensitive electronic instruments to assure perfect contact between the winding and the contact brush.

Standardize on Ohmite Rheostats for unsurpassed dependability, smoothness of operation, and long life.



A COMPLETE LINE OF RHEOSTATS

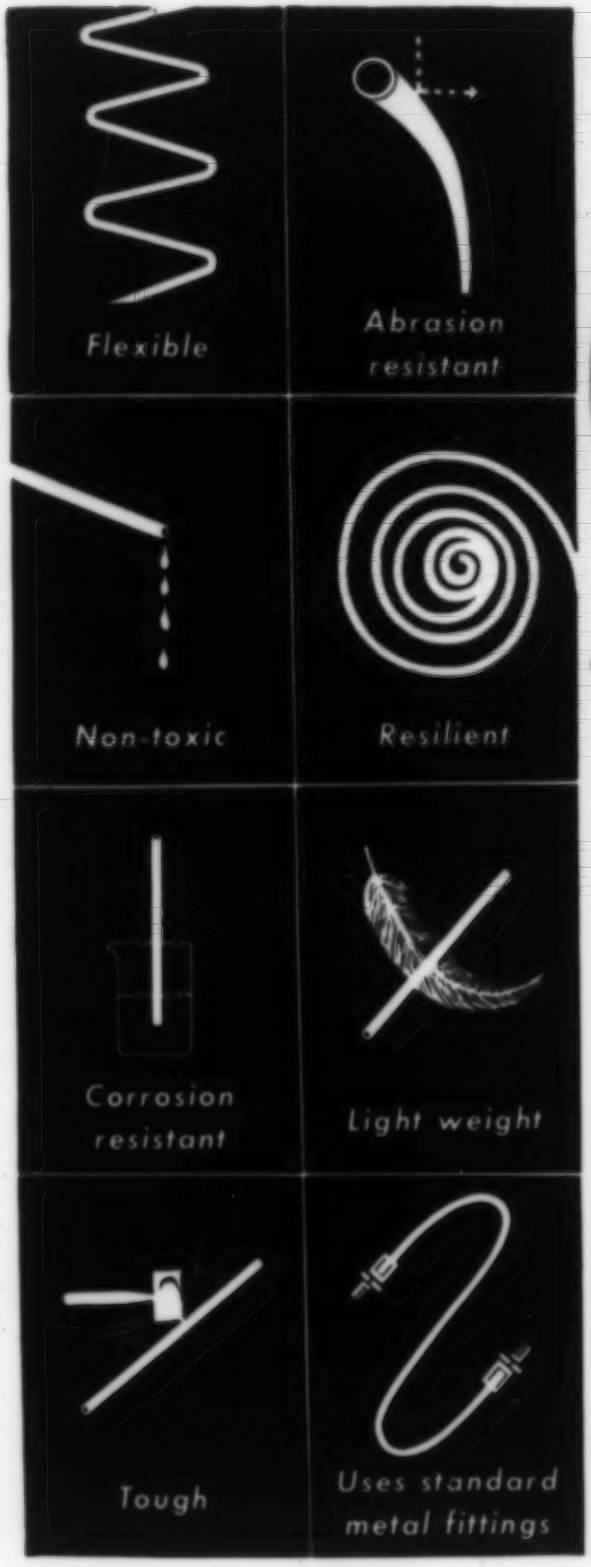
from 25 to 1000 watts. Also available to meet MIL-R-22A requirements in each of the 26 type designations.

Write on company letterhead for Catalog and Engineering Manual No. 40.

Be Right with OHMITE®

OHMITE MANUFACTURING COMPANY, 3618 Howard Street, Skokie, Illinois (Suburb of Chicago)

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES



New nylaflow* tubing is all these things ...and more!

NYLAFLOW . . . the new POLYPENCO® nylon tubing . . . now permits you to get all the advantages of nylon in pressure lines for lubricants, air, fuel and oil, coolants, process streams, and hydraulic fluids.

With all its superior performance, NYLAFLOW tubing costs less in some small sizes than copper tubing. And it costs much less than flexible rubber hose.

Another thing, NYLAFLOW costs less to install. There's no pre-bending . . . no intermediate fittings . . . no flexible hose attachments. Instead, NYLAFLOW can be run in continuous lengths and connected simply by using a standard metal compression or flare fitting at each end. Because it's flexible and light weight, NYLAFLOW tubing also simplifies prefabrication of tubing assemblies.

NYLAFLOW tubing is now available in stock diameters and lengths. There are two grades: Type T with a tested bursting strength of 1,000 psi; and Type H, 2,500 psi. The tubing also is available in colors for color coding.

SEND FOR NEW *NYLAFLOW* TUBING BULLETIN

THE POLYMER CORPORATION of Penna. • Reading, Penna.

In CANADA: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

POLYMER *NYLAFLOW* TUBING

. . . nylon . . . Teflon† . . . and other non-metallic shapes

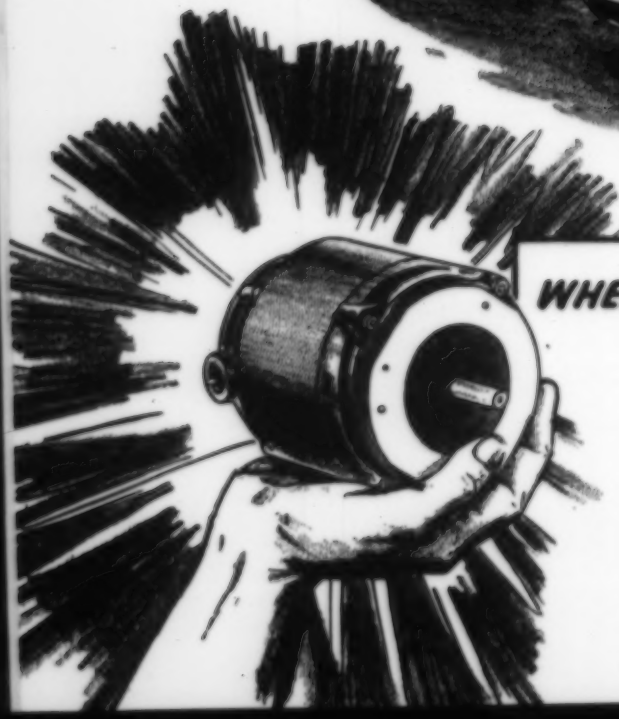
†Teflon is the trademark for DuPont tetrafluoroethylene resin

*NYLAFLOW is the trademark for The Polymer Corporation's nylon tubing

DESIGN SOLUTIONS with G-E

G.E. OFFERS SPECIAL SOLUTIONS FOR YOUR SPECIAL ELECTRIC-DRIVE PROBLEMS

DID YOU KNOW GENERAL ELECTRIC'S SPECIALTY COMPONENT MOTOR DEPARTMENT DESIGNS AND BUILDS THOUSANDS OF SPECIAL MOTORS AND GENERATORS TO SOLVE SPECIAL ELECTRIC-DRIVE PROBLEMS ON YOUR PRODUCTS? THIS DEPARTMENT'S COMPLETE SPECIALTY-MOTOR LINE INCLUDES A WIDE VARIETY OF SMALL AC AND DC MOTORS AND GENERATORS, ALTERNATORS, AMPLIDYNES, TACH GENERATORS, DYNAMOTORS, AND UNIVERSAL MOTORS. AND THE G-E MOTOR ENGINEERS READY TO WORK WITH YOU WILL EXPERTLY MODIFY BASIC DESIGNS TO PROVIDE THE CHARACTERISTICS, ENCLOSURE, SIZE AND SHAPE, AND SPECIAL ACCESSORIES **YOU** REQUIRE FOR **YOUR PRODUCTS.**

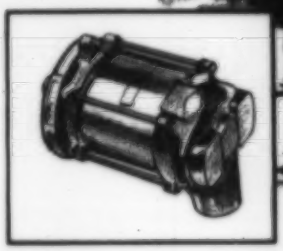


WHERE CAN YOU USE THIS NEW, GEARLESS LOW-SPEED AC MOTOR?

ONLY G.E. OFFERS THIS SYNCHRONOUS INDUCTOR MOTOR—OPERATING AT LOW SPEED ON 115 OR 230-VOLT AC POWER. LIMITLESS USES INCLUDE MOTOR-OPERATED VALVES, MACHINE TOOLS, REMOTE-CONTROL SYSTEMS. RAPID ACCELERATION, DECELERATION, REVERSING. SEALED-IN LUBRICATION FOR LONG LIFE.

TWO MODELS: 75 RPM, 75 OZ-IN.; 100 RPM, 2 OZ-IN.

specialty motors



SPECIAL G-E ALTERNATOR PUTS PINEAPPLE HARVESTING ON A 24-HOUR BASIS

... SPECIALLY DESIGNED G-E ALTERNATORS — RATED FOR CONTINUOUS DUTY IN AMBIENT TEMPERATURES UP TO 120°F — NOW PROVIDE POWER FOR FLOODLIGHTS AND SMALL HAND TOOLS ON HUGE PINEAPPLE HARVESTING MACHINES. THIS PERMITS HAWAII'S PINEAPPLE GROWERS TO OPERATE ROUND-THE-CLOCK TO GATHER THE FRUIT AT THE PEAK OF PERFECTION. **G-E APPLICATION "KNOW-HOW" PLUS QUALITY DESIGN AND MANUFACTURE** ASSURE LOW MAINTENANCE, MINIMIZE DOWNTIME.

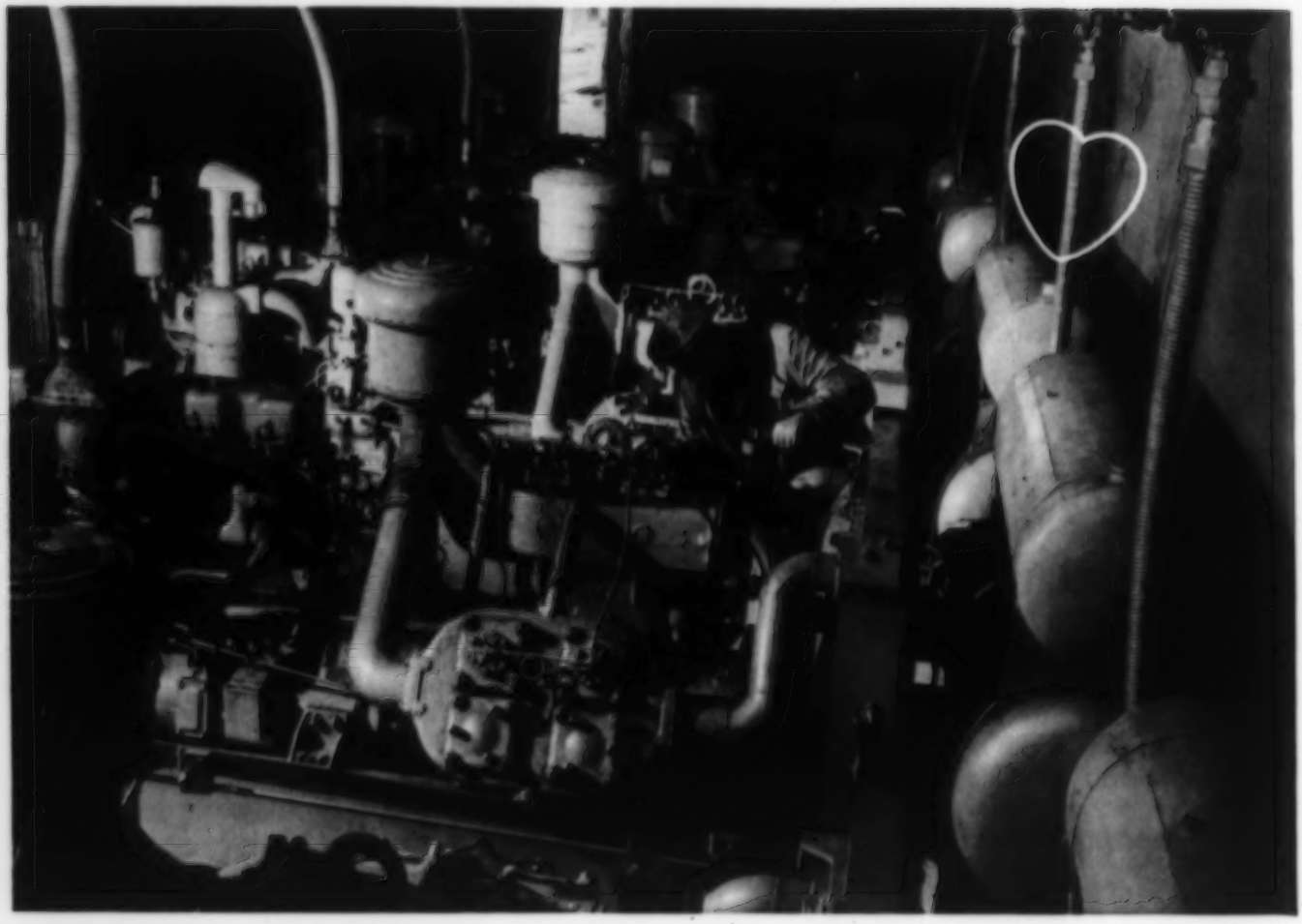
AVAILABLE: COMPLETE ENGINEERING ASSISTANCE FOR YOU!

HERE'S THE SPECIAL ATTENTION YOUR PROBLEMS GET AT G.E.: 1. YOUR LOCAL G-E APPARATUS SALES ENGINEER LEARNS ALL ABOUT YOUR NEEDS FROM YOUR DESIGN PEOPLE. 2. HE CALLS IN A TEAM OF FACTORY ENGINEERS WITH YEARS OF MOTOR APPLICATION EXPERIENCE. 3. AT THEIR DISPOSAL ARE G.E.'S COMPLETE DEVELOPMENT AND TESTING FACILITIES. 4. IN SHORT ORDER, A SAMPLE G-E MOTOR IS READY FOR TESTING ON YOUR PRODUCT.

FOR THIS COMPLETE HELP, CONTACT YOUR NEARBY G-E APPARATUS SALES OFFICE, TODAY. OR IF YOU PREFER, **WRITE** GIVING FULL DETAILS TO SECT. 704-58, GENERAL ELECTRIC CO., SCHENECTADY 5, N.Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC



TAKES POUND OUT OF AIR POUNDING

DURABLE Penflex TUBING ABSORBS NOISE . . . VIBRATION . . . PUNISHMENT

"Transports air, but not the vibration" is remark often heard about Penflex tubing installed on air intake and exhaust lines. And for this room where a battery of eleven air compressors are operating, that can mean a lot of air in motion . . . and plenty of noise eliminated.

There's no question of air leakage, either. Penflex four-wall interlocked flexible tubing is as tight as the proverbial drum. In durability it has the edge over rigid pipe, for the many interlocked sections have a "give" which soaks up the minute but ceaseless vibration which causes ordinary pipe to fracture . . . in addition to absorbing an ear-splitting din.

Penflex tubing can be built up to pressures . . . or down to size—as small as ⅛" I. D., or as large as 24" I. D. Different types, weights and materials are available. Selection of the tubing best suited for the job is a specialized segment of engineering . . . "Flexineering," we call it.

Penflex engineers will help you to "Flexineer"—one job or an entire plant—for steam or Diesel power generators, compressor stations, various oil, water and steam circulating lines, bulk unloading, or a host of other jobs.

You'll find our booklet "Flexineering" helpful, too. Write for a copy today.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7239 Powers Lane, Philadelphia 42, Penna. • *Branch Sales Offices:* Boston New York • Chicago • Houston • Cleveland and Distributors in Principal Cities

flexineering by

PENFLEX

HEART OF INDUSTRY'S LIFELINES

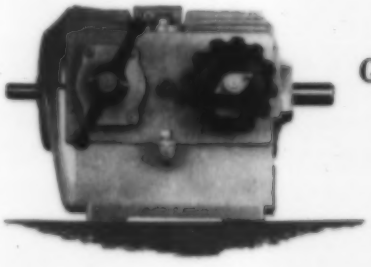
FLEXIBLE TUBING, AUTOMATIC BARREL FILLERS, PNEUMATIC RIVET PASSERS, ACCESSORIES AND FITTINGS

This is one form of Braking Action

. . . very passé, to be sure; but many manufacturers are using variable speed devices with brake motors that are just as out of date and ineffective as the junk man's old shoe.

The progressive machine designer is specifying the new GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION; featuring friction-free, positive braking action. Find out about this and all of the other exclusive features offered by GEROTOR in this new transmission.

For complete details and free literature . . . write:



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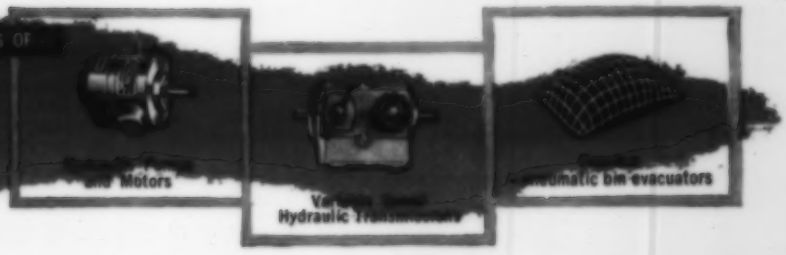
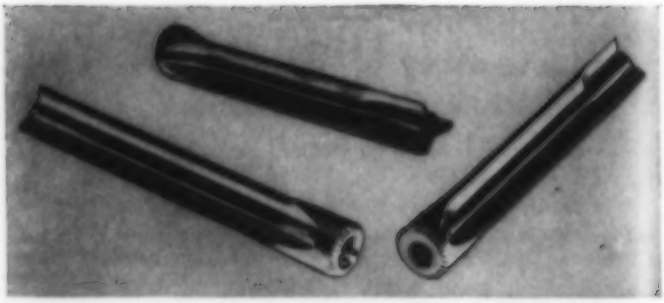


WIDE ENDURO BELT ...keeps scratches off bandages

CORROSION RESISTANCE IN TUBULAR FORM. Republic's Steel and Tubes Division turns out miles of ENDURO Stainless Steel Tubing for the process industries and for mechanical applications. Republic ELECTRUNITE Stainless Steel Tubing and Pipe offer the identical high mechanical and corrosion-resisting properties demonstrated in sheet form by the Reynolon belt. Call Steel and Tubes for application assistance on all your fluid handling and tubing problems.



WHAT'S EVEN MORE CORROSION-RESISTANT? REPUBLIC TITANIUM. Titanium surpasses even stainless steel in resistance to many severe forms of corrosion. Yet, it weighs only 56% as much as alloy steel. Here, Republic Titanium supplies corrosion-resistance and lighter weight to parts designed to knit human bones. Republic Titanium and Titanium alloys now are available for civilian applications. Republic has the experience to help you use them best. Write us.

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
3130 East 45th Street,
Cleveland 27, Ohio

I'm interested in additional information on:

- ☐ Republic ENDURO® Stainless Steel
- ☐ Stainless Metallurgical Assistance
- ☐ ELECTRUNITE® Stainless Steel Tubing
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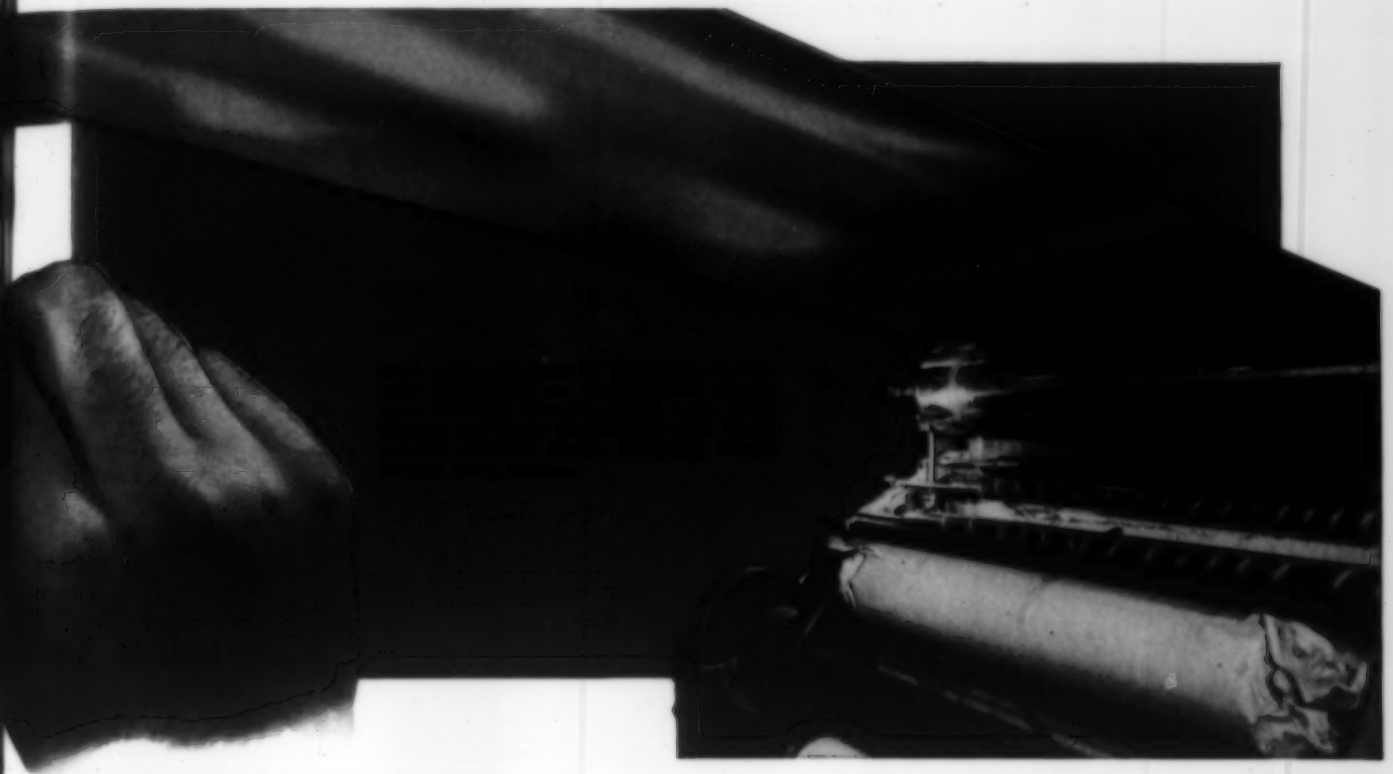
K-581

NO CONTAMINATION—NO SPOILAGE. Republic Steel offers a full range of barrels, drums and pails in a variety of metals and finishes to protect your chemical, food and other products. Choose from ENDURO Stainless Steel, hot dipped galvanized steel, hot dipped tinned steel, mill galvanized sheet steel, hot rolled open hearth steel, plain or lacquer lined. Choice of gages to meet all handling and shipping requirements. Many styles in sizes up to 55 gallons. Contact Republic.



This wide, polished ENDURO Stainless Steel belt carries Reynolon plastic coatings in process. One such type makes the peel-off backing for those handy packaged small bandages you use.

The ENDURO surface provides a high luster finish! Since the slightest scratch would be "mirrored" or duplicated in the finished product, the quality of the stainless steel surface determines the quality of the plastic coating. Here, ENDURO keeps scratches off bandages!

Note that the belt is supported only by top rollers. That allows both sides to carry the plastic material . . . speeds production. It also means that the belt must have great tensile strength. ENDURO supplies that strength. In this case, tension on the belt runs as high as 90 tons.

What's more, this belt must be heat-resistant. In process, material passes through 600° ovens. And, many of the plastics processed are in hydrous or acidic solutions. So, the belt must resist rust and corrosion. ENDURO does just that.

Four of these sixty-inch wide belts help produce Reynolon plastic film. Even at this extreme width, the belts must stay flat. "Crowned" metal could snap like an oil can and damage the plastic.

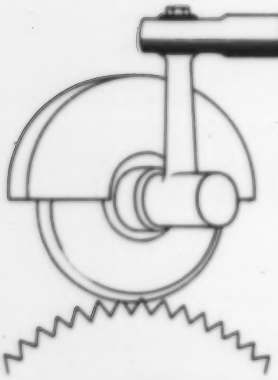
Republic metallurgists worked closely with Reynolds Metals Company, Plastics Division, to develop this unusual equipment. If you have process or product problems involving heat, corrosion, surface finish or strength, ENDURO Stainless Steel quite likely is your answer. Republic metallurgists will help you apply it most profitably. Write Republic.

REPUBLIC STEEL

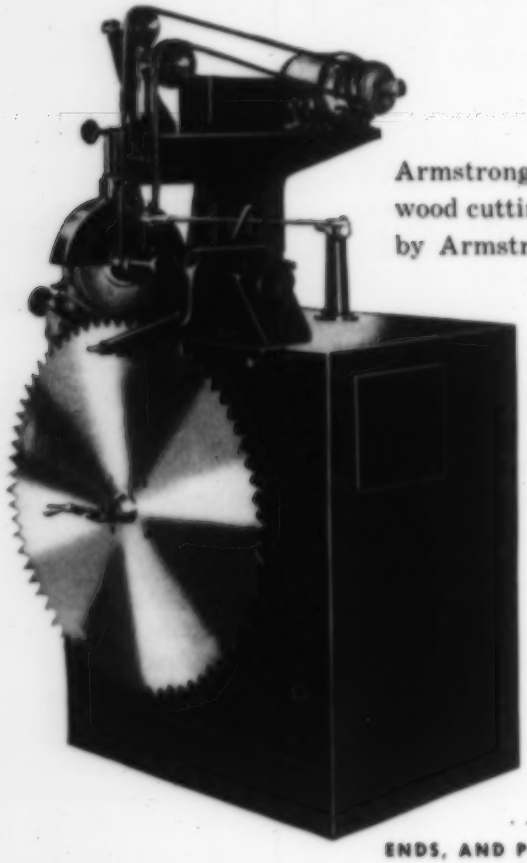
World's Widest Range of Standard Steels and Steel Products

HEIM
RODENDS

control amount of bevel



Here is a push-pull application with a Heim Unibal Rod End at each end, to provide the universal motion for changing direction of the grinding wheel smoothly, quietly, and with precision, for extreme sensitivity in grinding fine teeth.



Armstrong Sharpeners are made to sharpen wood cutting circular saws automatically. Made by Armstrong Mfg. Co., Portland, Ore., there are sharpeners to handle saws up to 60″, 72″, and 120″ in diameter. Provision is made for adjusting these machines to bevel the face of the tooth up to 35 degrees in each direction.

The Heim Unibal bearing consists of a single ball rotating in a bronze bearing race. It has a large surface-supporting area, and it corrects misalignment in all directions.

. . . BE SURE YOU HAVE THE HEIM CATALOG OF BEARINGS AND ROD ENDS, AND PLEASE FEEL FREE TO WRITE OUR ENGINEERING DEPARTMENT ABOUT YOUR LINKAGE PROBLEMS . . .

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

BALTRIC...

THE MOTOR THAT COULDN'T

BE BUILT BEFORE

Now, in a complete line of totally enclosed motors, Baltric brings you the best answer yet to your motor problems. Less weight . . . less bulk . . . better performance, are the results of advanced engineering and new and better materials.

The new Baltric Motors pack much more power per ounce . . . permit applications and installations of greater versatility. Simple in design, rugged, yet compact and dependable, Baltric does a better job in less space than old-style motors. Baltric is a better bet for every use.

Baltric Motors are available in a complete range of models, ⅛ h. p., through 5 h. p., squirrel cage induction type, both polyphase and single phase. Baltric Motors can also be engineered to meet your special mechanical and electrical requirements.

Original Streamcooled Baldor Motors Available—Built to Former NEMA Standards

ALL BALTRIC MOTORS TOTALLY ENCLOSED AND *STREAMCOOLED*

BCSS-3

ALDOR ELECTRIC COMPANY

Baltric Motors Are Available in Polyphase
Squirrel Cage · Induction and Single Phase
Capacitor Start · Induction Run Types

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NEW

When strategic aircraft requirements indicated a NEW type of universal joint, MECHANICS engineers developed it. Design, metals, machining, tolerances, heat-treating, hardening, stamina, balance and lubrication — all were adapted to specific aircraft precision. Let MECHANICS engineers design and build universal joints that are equally well suited to the exact power transmission needs of your product. The competitive advantages that designed-for-the-job MECHANICS Roller Bearing UNIVERSAL JOINTS provide, are well worth investigating—while your new models still are on the drawing board.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner 2032 Harrison Ave., Rockford, Ill.

MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery •
Aircraft • Tanks • Busses and Industrial Equipment

free! this informative booklet on...

"How forged weldless rings and flanges improve your product and cut your costs"

Standard Steel Works Division
BALDWIN-LIMA-HAMILTON

When you consider a change in your product, you expect that change to make money for you or to save money for you.

It's quite possible that Standard Steel Forged Weldless Rings and Flanges will do *both*.

They improve your product, thus making your sales task a little easier, and they cut your manufacturing costs. In many cases, first cost may be less than the component you now use, and always machining time is less.

In checking through this detailed booklet, you'll be able to determine in five minutes or less whether they're worth investigating further. Send the coupon now.

Dept. 8764, Standard Steel Works Division
Baldwin-Lima-Hamilton Corporation, Burnham, Pa.

Please send me Bulletin No. 10,000, "How Forged Weldless Rings and Flanges Improve Your Product and Cut Your Costs."

Name _____ Title _____

Company _____

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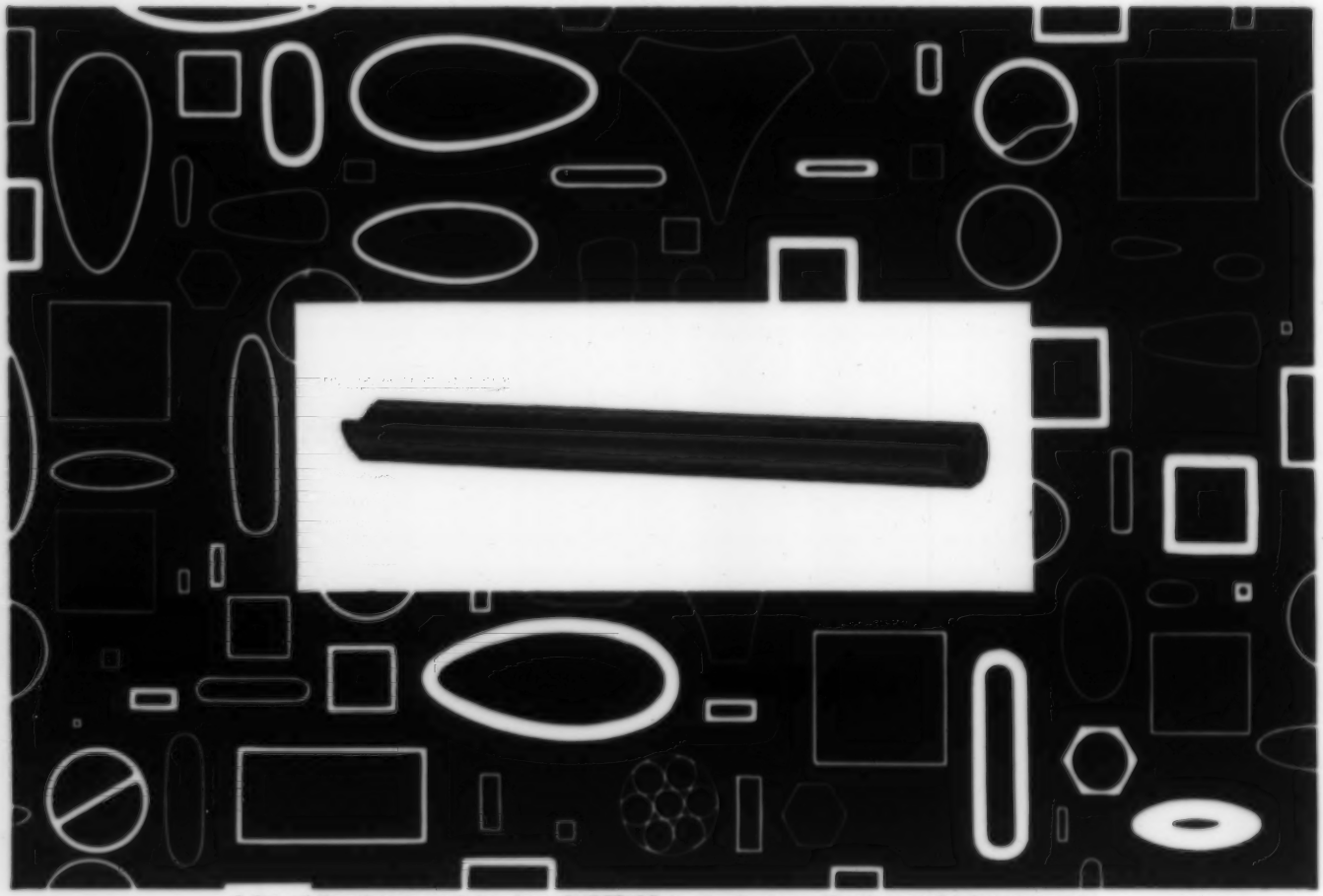
City _____ Zone _____ State _____



A few of the shapes available from SUPERIOR in standard specifications and tolerances or to your own design. The tube in the foreground is a gun drill shank made from 4130 alloy steel.

Save time and money on special shaped tubing

"SUPERIOR" TUBING IS IMMEDIATELY AVAILABLE IN A WIDE RANGE OF SHAPES, FORMS, ALLOYS

Many manufacturers have discovered that SUPERIOR's ability to supply as standard what many firms consider specialty tubing saves them trouble, time and money. SUPERIOR makes round, square, oval, rectangular, elliptical and flat oval tubing, for instance. It makes capillary tubing, pointer tubing, electronic tubing, telescopic sizes, large OD-light wall tubing. Over 55 analyses are available in carbon, alloy and stainless steels; in nickel and nickel alloys; in beryllium copper, titanium, zirconium.

The gun drill shank shown above and on the right is a good example of SUPERIOR's ability to supply unusual shapes. This newly rediscovered method of producing close-tolerance high-finish holes demands straight, rigid, accurate shanks with a 110° V-groove. SUPERIOR can produce such a shape—and others—in a fraction of the time and cost it would take a customer to form his own.

If you're having difficulty getting the kind of tubing you want, SUPERIOR can undoubtedly help you. Write for your free copy of Bulletin 40—*A Guide to the Selection and Application of Superior Tubing*. SUPERIOR TUBE COMPANY, 2010 Germantown Ave., Norristown, Pa. *On the West Coast:* Pacific Tube Company, 2010 Smithway St., Los Angeles 22, Calif.

Turks-head rollers converting a round section of SUPERIOR tubing into the typical elliptical shape for a Bourdon gage tube.

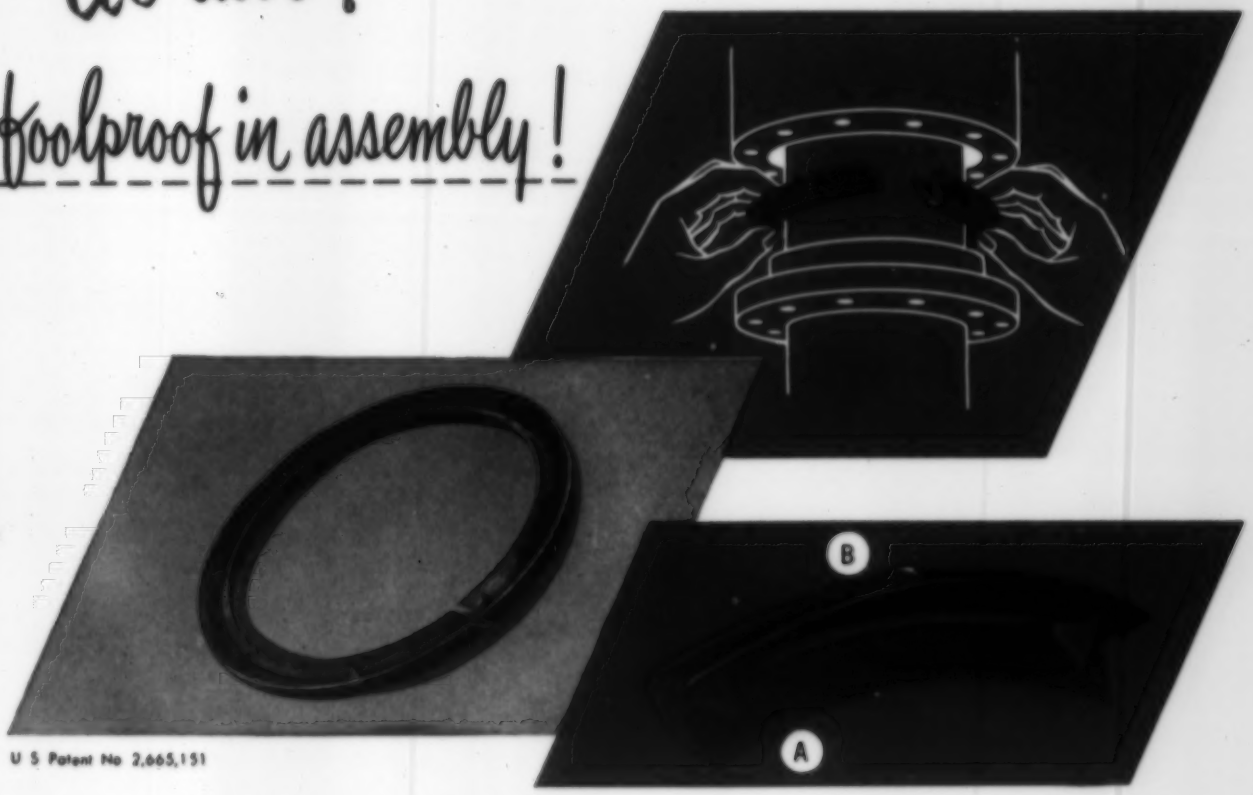
Gun drills can produce holes from 4 to 230 diameters or more in 4 times the speed of conventional drilling methods or better. Holes so produced are straight and round to tolerances of 0.0002" or less and wall finishes are 7 mu-in or better.

All analyses available in .010" to ½" OD; certain analyses in light walls up to 2½" OD

Superior Tube

The big name in small tubing

At last! a really leakproof ring that is foolproof in assembly!



U S Patent No 2,665,151

Linear VEE-DAM rings make other hydraulic packing obsolete

NO OTHER PACKING DESIGN has ever done it! But now LINEAR assures split V-Ring packing that's absolutely leakproof, regardless of the fit at the ring joints!

Even when gaps occur, through careless assembly or variations in bore size, LINEAR VEE-DAM RINGS completely eliminate labyrinth flow. Sturdy rubber dams (A) in the grooved hinge area of each ring hermetically seal center groove sections when rings are stacked together. And lateral leakage is prevented by external abutments (B) on ring shoulders.

LINEAR VEE-DAM RINGS save on installation and maintenance . . . last longer . . . reduce down time. They're the first real achievement in hydraulic packing design for a quarter century. We're molding them in a variety of sizes and compounds to meet extremes of temperature and pressure.

GET ALL THE FACTS NOW!

PERFECTLY ENGINEERED PACKINGS

LINEAR

LINEAR Inc. STATE ROAD & LEVICK ST. PHILA 35 PA

NOW no bead,

CONTOUR-WELD PIPE...BEST BY ANY TEST YOU CAN NAME

no undercut

in new type welded stainless steel pipe

Now, TRENTWELD is better than ever! Thanks to Trent's new patented *Contour-Weld** process, you can now get stainless pipe or tubing that's really smooth inside . . . free from any undercut or projecting weld bead.

Check these Benefits

As before, this new-type TRENTWELD is made from uniformly rolled stainless strip. That's why you'll always get extremely high uniformity both of wall thickness and curvature. And Trent's new *Contour-Welding* brings that same uniformity to the weld zone itself. This means a stronger pipe or tube with smoother flanged or flared ends . . . no cavitation corrosion or erosion . . . better performance in every category than with any other, welded or not.

Try new Trent *Contour-Welded* pipe or tubing for yourself. It's a natural for pressure lines . . . lines carrying corrosive chemicals . . . high-velocity systems. And remember, it's made by Trent — tube-mill specialists.

Why Trent's Exclusive *Contour-Weld* Process Means Smoother Welds . . .

With conventional welding, gravity means beads . . . or undercut, particularly in heavy sections. Gravity pulls some of the molten metal down into the pipe to form a bead that is extremely difficult to remove by cold working. And cold working of the inside bead can lead to undercuts, focal points for erosive and corrosive attack. Cleaning becomes difficult.

With new Contour-Welding, gravity means smoothness. Trent's new *Contour-Welding* puts gravity to work. The pipe is inverted, and welded at the bottom. Gravity still pulls the molten metal down — but that simply makes the weld-bead contour correspond to the contour of the pipe itself. That's why there's no tell-tale bulge of weld metal on the critical inside surface. And even on the outside, the weld bead more closely approaches that of the parent metal than other welded pipe.

Contour-Weld is the trade mark of the Trent Tube Co. for its process of welding pipe and tubing which is protected under U.S. Patent 2,716,692.

TRENTWELD **STAINLESS STEEL TUBING**

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

FOR WELDMENTS

**Complex or Simple—
in any combination of
Weldable Materials**

Count on STRUTHERS WELLS

Whether they be large, heavy and accurate or small and precise . . . whether they comprise a complete unit or a component for your own fabrication—come to Struthers Wells!

Using the extensive facilities of three modern plants, Struthers Wells combines plate, rolled sections, forgings, small castings and other elements as required. Struthers Wells does the entire job, being equipped for forging, cutting, welding, heat treating, testing and machining—in any degree of precision, size and quantity. *Write for Weldments bulletin.*

Struthers Wells

STRUTHERS WELLS
CORPORATION
TITUSVILLE, PA.

Plants at Titusville and Warren, Pa.
Offices in principal cities

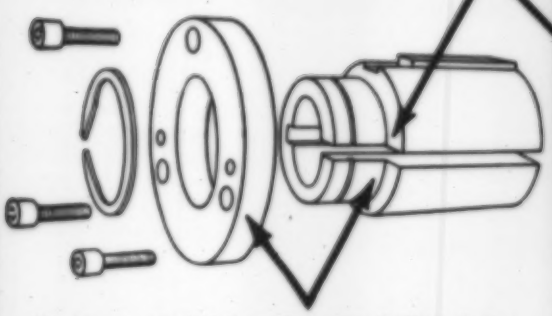
Get the ONLY SHEAVE with ALL these needed features

TEXROPE Sheaves with MAGIC-GRIP Bushings

Full-length bushing key for uniform torque transmission along entire bushing.

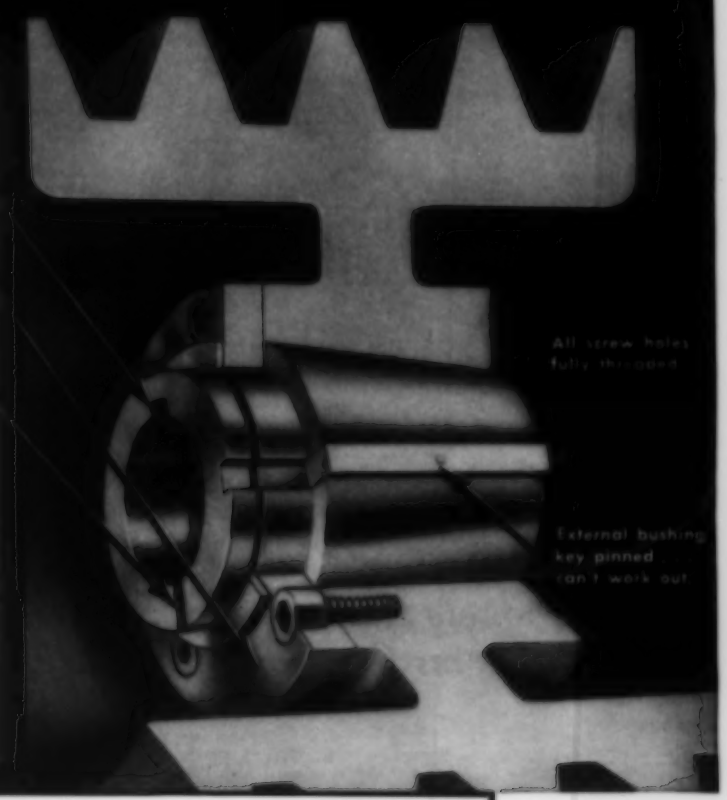
Floating collar allows cap screws to draw sheave on taper of bushing without binding — collar takes no torque.

Full-length split and uniform section provide uniform grip over entire contact surfaces.



No torque carried by screws as all torque is transmitted through keys.

Two-piece bushing (cast-iron sleeve and free-floating collar).



Here's Comparison of *Magic-Grip* Sheave and Other Sheaves

	Magic-Grip Sheave	Sheave A	Sheave B	Sheave C
Bushing fully split and uniform in section for full-length, full-circumference grip.	Yes	Yes	No	Yes
Torque carried by keys instead of threaded bolts.	Yes	No	No	No
All screws engage all threads fully.	Yes	Yes	Yes	No
Mounts in one piece.	Yes	No	Yes	Yes

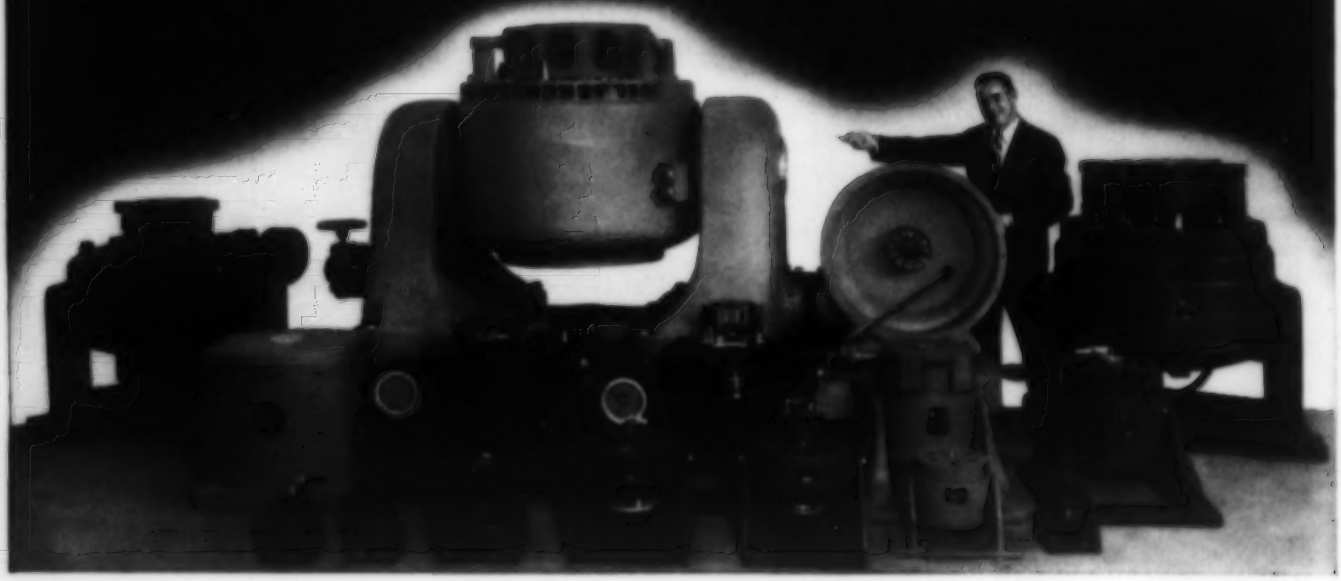
See Your Allis-Chalmers District Office or Authorized Distributor

Texrope and *Magic-Grip* are Allis-Chalmers trademarks. A-4552

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Look at this progress in vibration exciters



A whole range of MB Shakers developed to handle any vibration testing program . . . deliver reliable, quantitative data

One pound to over twelve thousand pounds . . . that's the range of force outputs in this group of MB electrodynamic vibration exciters. On the way are shakers for 25,000, 50,000 and even 100,000 pounds! All operate over substantial frequency range. What a far cry from the limited scope of mechanical shakers . . . the only type available just a short ten years ago.

But force and frequency range are not the only improvements. MB has long recognized the need for *pure* table motion if test results were to be quantitative and reliable.

Thus, in MB Shakers, moving-element structures are very rigid. This minimizes table motion distortion in the testing range. Also, because MB power supplies are designed for negligible harmonic distortion, table waveform is pure over the whole frequency range.

There's more. MB has designed complex wave testing systems that shorten test time and give truer reproduction of actual service conditions. Also oil-filled exciters capable of operation at "100,000 ft. altitude," −100 to +200°F, and 20 to 95% relative humidities. Also cycling systems that do time-consuming test procedures *automatically*.

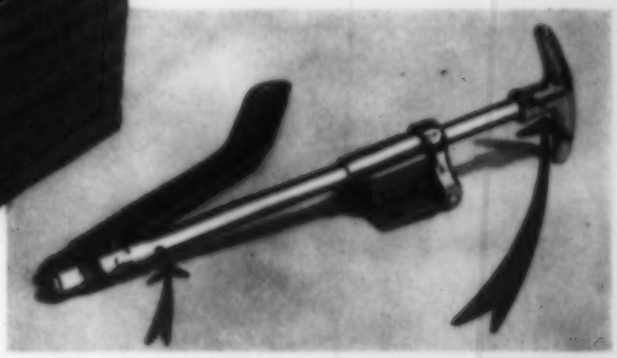
If you're working on projects that call for environmental testing, or fatigue testing, or noise determinations . . . you can benefit from vibration testing with MB shakers. Work with a leading source of help and information in this growing field . . . contact MB. For details and specifications on MB Exciters, send for Bulletin 420-3.

MB *manufacturing company*
A division of Textron American, Inc.
1060 State Street
New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION . . . TO EXCITE IT . . . TO MEASURE IT.

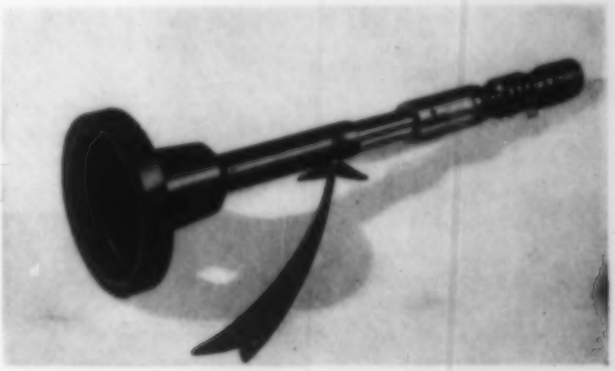
3 Better Methods with ROLLPIN

TO REPLACE A RIVET Rollpin's spring action firmly fastened radio transformer laminations in place and did two things a rivet couldn't do—aligned the laminations and compensated for minor hole variations.



TO REPLACE A STOP PIN Rollpin's self-locking action eliminated staking or peening operations required to retain a straight solid pin.

TO REPLACE A SET SCREW on automobile brake handle, Rollpin is self-retained in the hand grip but can easily be driven into overdrilled hole in shaft to free handle, then removed and used again.



TO REPLACE A DRIVING PIN for a flexible drive shaft on a washing machine, Rollpin cut assembly costs by eliminating precision drilling and reaming

Where can you use this simple fastener?

If you use locating dowels, hinge pins, rivets, set screws —or straight, knurled, tapered or cotter type pins, Rollpin offers the opportunity of a better method that can cut assembly and maintenance costs. This slotted tubular steel pin with chamfered ends eliminates special machining, tapping, and the need for precision tolerances. Driven into a hole drilled to normal production standards, it locks securely in place, yet can readily be drifted out and reused whenever necessary.

ELASTIC STOP NUT CORPORATION OF AMERICA

ROLLPIN TRADEMARK

MAIL COUPON FOR DESIGN INFORMATION

Elastic Stop Nut Corporation of America
Dept. R37-124, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastener information:

- ☐ Rollpin samples
- ☐ Rollpin bulletin
- ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

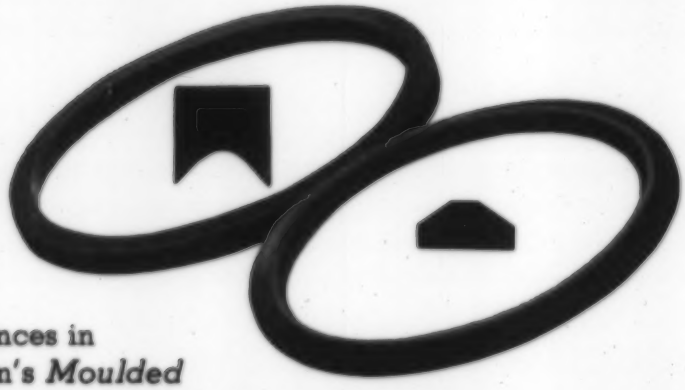
Firm_____

Street_____

City_____ Zone____ State_____

Brand New HOUGHTON Development!

MOULDED "V" PACKING ADAPTERS



In one of the most *important* advances in Packing Design in years—Houghton's *Moulded* Adapters (Support Rings) for "V" Packings bring these new advantages:

1 BETTER SEALING

This moulded, yet resilient bronze ring expands under pressure, helping to form a perfect seal.

2 NO FATIGUE CRACKING

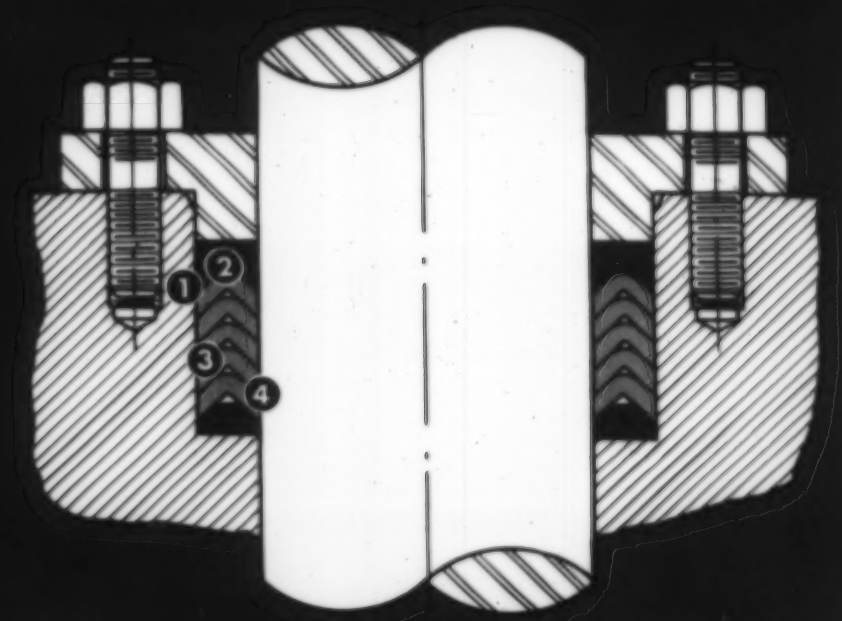
Houghton Adapters will withstand continuous flexing without fatigue cracking. Wear and breakage normally is reduced.

3 SAFER PACKING

Because of tighter seal, packing cannot extrude around flange ends. This saves packing and reduces friction.

4 NO CYLINDER DAMAGE

Houghton Adapters are tough and durable but will not abrade or score cylinder walls.



Get the complete story on this new development by writing to Packing Research Division, E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

E F HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

At an Eastern food processing plant, slices of No. 1 potatoes up to 1 ¼-inch are pumped at 80 RPM, smaller diced No. 2 potatoes at 150 RPM. Mixers feed the salad into hoppers leading into the pump. A B-10 Moyno food pump moves the large slices gently through the pump and a 4-inch glass pipe into standard filling machines that fill pint, quart, and gallon jars. When the Moyno isn't pumping potato salad, it pumps other foods such as cooked cranberries, whole-kernel corn, pickle relish.

Unusual Pumping Problem? Maybe This Moyno® Pump Can Help You Solve It

The Moyno can pump potato salad and a lot of other materials without making mush out of them—because of the unique *progressing cavity* principle.

Moynos have no valves and pistons, no vanes or other devices that cause churning and turbulence. The Moyno has a simple screw-like rotor turning within a double-threaded stator. This design creates cavities which progress smoothly toward the discharge end of the pump, carrying the material being handled. The material is not squeezed or churned.

Pumps Practically Anything

That's why the Moyno successfully handles such hard-to-pump materials as non-pourable pastes, frits, plaster, highly volatile liquids, and materials containing large particles, such as potato salad, fruit, cherries, chow mein—even oysters! In fact, the Moyno handles practically anything that will pass through a pipe.

Wide Range of Sizes

Moynos pump many hard-to-pump materials with a minimum of abrasion and wear. Many plants have adopted Moynos simply because they last so long.

Moynos provide positive displacement. Moynos can pull up to 29 inches vacuum while discharging under pressure. Big Moynos deliver up to 500 gpm; can provide pressures up to 600 psi in the smaller frame sizes. They even get up to 1000 psi momentarily.

The Moyno is reversible—it pumps equally efficiently in either direction.

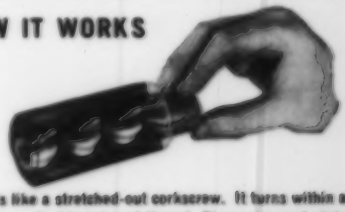
With the Moyno, accurately metered flows are obtainable by regulating operating speed.

Moynos are trouble-free. They are self priming; won't cavitate or vapor-lock. There's just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain. Moyno pumps are easy to take apart for cleaning.

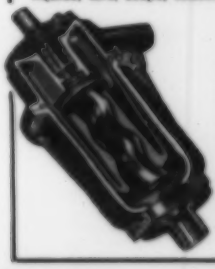
Write For Bulletin

You may save a good deal of money or solve a tough problem by finding out about this simple, versatile pump. Write for Bulletin 30MD.

HOW IT WORKS



Rotor is like a stretched-out corkscrew. It turns within a stator that has a double internal thread. Thus rotor and stator form closely fitted cavities. As the rotor turns, these cavities progress evenly toward the discharge end of the pump without closing up. That's why the Moyno easily handles materials without crushing, churning, or aerating; and why it can handle so many different things—solids in suspension, pastes, abrasives, highly volatile liquids, tars, soaps, caustics—even cement and plaster.



FOR DESIGN ENGINEERS

Moynos are available in small sizes and special designs for use in automatic washers, drink dispensers, sprayers, oil burners, machine tools, gasoline pumps, and a wide variety of other equipment. If you are designing machinery, we'll work with you, in confidence, to integrate pump design with your problem.

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

R&M •

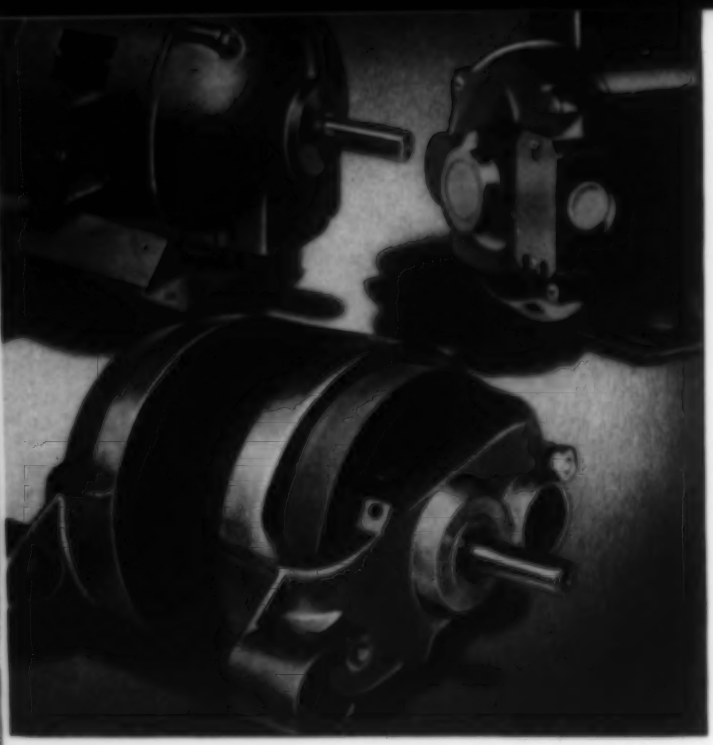
Fractional and Integral HP Motors

Desk, Window, and Household Fans

Hoists and Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment



Complete Motors ... or Motor Parts

Let your design problem make the choice!

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed at right:

Portable Saws	Vacuum Cleaners	Portable Grinders
Drills	Files	Sirens
Nut Setters	Sanders	Hair Driers
Hammers	Pumps	Advertising Devices
Routers	Compressors	Ventilating Equipment
Screw Drivers	Hones	Oil Burners
Hedge Trimmers	Business Machines	Surgical Instruments
Lawn Mowers	Cast Cutters	Grease Guns
Nibblers	Food Mixers	Vibrators
Lock Mortisers	Polishers	Die Sinkers
Valve Grinders	Planers	Waxers

The machine that tests motor performance . . . in minutes instead of months!

Formerly it took months to do a really thorough job of calculating motor performance and requirements for a given job. Now, using the unique R & M "Electrical Slide Rule," the performance of any one motor design can be calculated in about 20 minutes! Result? R & M can engineer a motor to your exact requirements . . . thoroughly, accurately, *and in time to meet your production and marketing schedules!*

You can expect quality . . . from every Robbins & Myers motor!

Here, for example, are some of the quality features built into R & M universal motor parts:

1. Every field coil has paper in the slots—in addition to standard taping. More insulation means longer motor life, fewer failures.
2. Insulating material is selected for the job. For example, glass insulated wires are used in sander and saw motors.
3. R & M motors are varnish-dipped and baked—as much as *three times* when service requires it.
4. Standardized commutators and laminations—for mass-production at no sacrifice in quality.
5. Diamond-turned commutators . . . for greater concentricity and smoother surface finish. Brushes last longer!
6. Matched Motor Parts are precision-built, 100%-tested, dynamically balanced, fully interchangeable.

How to select the best Fractional Horsepower Motors } FOR MACHINES, POWER TOOLS, APPLIANCES

The most important single factor in motor performance is *selection* of the right motor for the job. That's why R & M offers such a wide variety of types and sizes of motors and motor parts. From these many standard and special-standard types we can, in most cases, help you select the motor to help give your product the best all-around performance.

We Also Custom-Design, Economically!

Your problem may require a custom-designed motor. If so, we'd much rather work out a special motor for you than see you take an "off-the-shelf" compromise.

Ordinarily the extensive calculations required make custom-designing pretty expensive. We've licked that problem, too, with the unique R & M "Electrical Slide Rule." This is an electrical motor-performance calculator. With it, the designer can reduce the work of a whole day or two to about twenty minutes! Naturally you and we both benefit.

Some Other Advantages of R&M Motors

R & M offers some special construction features: extra insulation; glass insulation where heat requires it; diamond-turned commutators; extra varnish treatment; a gratifyingly low failure rate.

As a pioneer in the small motor field, we have designed and built millions of small motors for thousands of different applications. And so we naturally feel well qualified, with engineering skill and experience, and extensive manufacturing facilities, to do an exceptionally good job for you. At least, it won't cost you anything to find out.

Let Us Tell You More

Call the nearest branch office for an R & M Motor Specialist—or write us for the information in which you are interested. Use the check list below.

MD

ROBBINS & MYERS, INC., MOTOR DIVISION,
Springfield 99, Ohio:

. Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 200 HP
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

Name _____ *Title* _____

Company _____

Street _____

City & State _____

R&M MAKES BOTH!
Fractional horsepower motors and parts . . . from 1/200 h.p.

If it's an **R&M**, *it's the Right Motor!*

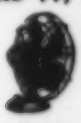
Integral Horsepower motors; famous R&M "All-Weather"* motor with sealed bearings. Up to 200 h.p.

*"*All-Weather*" *is an R&M trademark*

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

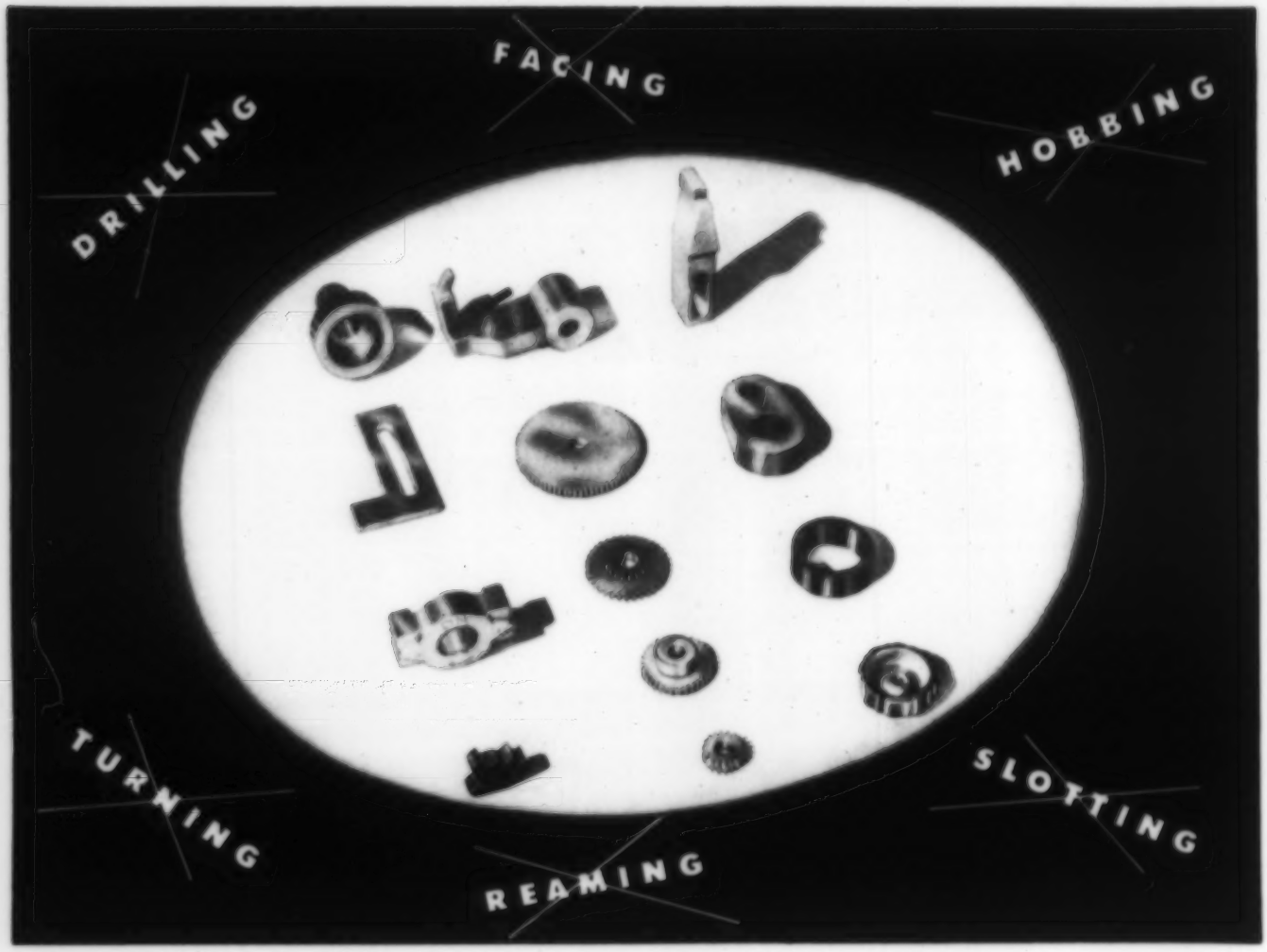
Fractional & Integral h.p. Motors & Generators


Electric Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment



PARKER Powdered Metal

Eliminates Machining Costs On Parts Like These...

PARKER
SALES ENGINEERS

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Ollie J. Berger Company • 2059 East 72 Street

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William H. Brasterman • 2174 Buck Street

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Cousens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F. Higgins, Jr. • 102 West Adams Street

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

One sure way to cut costs on small metal parts is to eliminate machining operations. Parker Powdered Metal produces the above parts in **one press operation** . . . complete . . . to close tolerances . . . at cost savings of from 70% to 90% compared with conventional machining methods.

And Parker Powdered Metal Parts offer other important advantages. Tensile strength, ductility, density, impact resistance and other physicals are closely controlled to meet exacting specifications. Tooling-up is done quickly and at relatively low cost.

It will pay you to check on the economies and design possibilities offered by Parker Powdered Metal. Just call the nearest Parker sales engineer listed here or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER

POWDERED METAL PARTS
ALUMINUM and ZINC
die castings

A new dimension in motors!

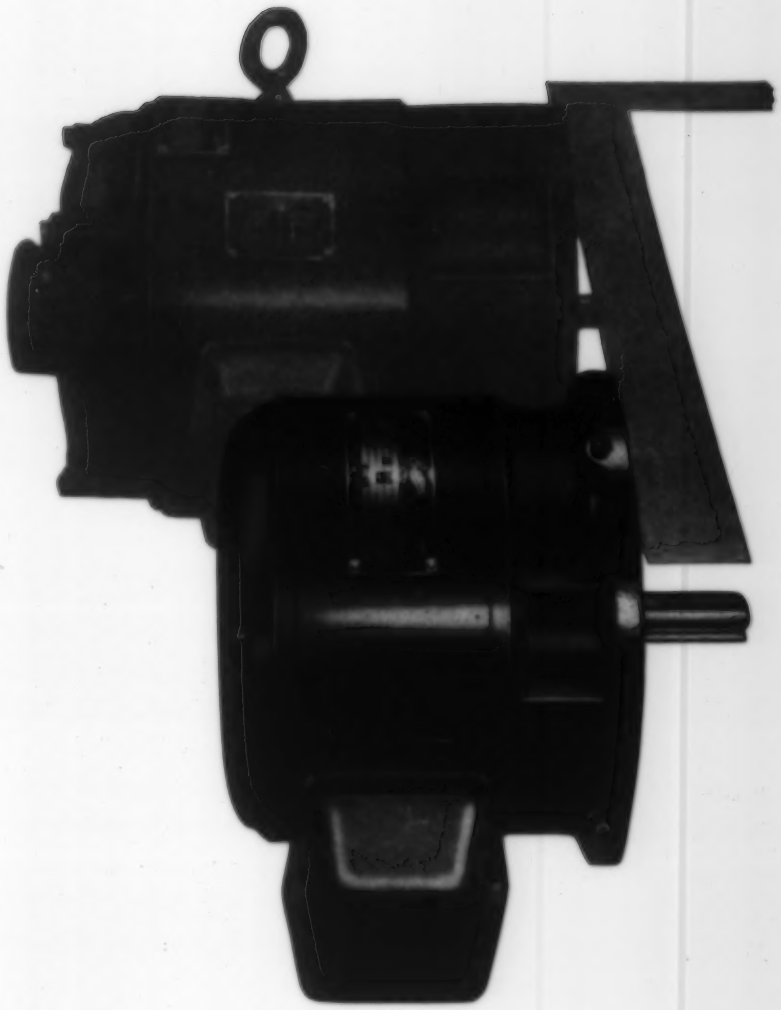
SHORTER **Century** Performance Rated® MOTORS

SAVE SPACE...
SAVE WEIGHT

This new line of shorter, round-frame, end-mounted motors by Century can give you greater freedom in design and engineering. They meet modern demands for compactness and weight-saving ... with even better performance.

No special mountings are required! These shorter Century motors have full-size NEMA "D" flanges. They are interchangeable with all other popular makes of standard end-mounted motors. The shorter motors are available in sizes from 1 to 15 H.P... in open or totally enclosed fan-cooled frames . . . for vertical or horizontal applications.

For full data, call your nearest Century Sales Office.



Performance Rated©
MOTORS
⅛ to 400 H. P.

CENTURY ELECTRIC COMPANY

1806 PINE ST., ST. LOUIS 3, MO. • *Offices and Stock Points in Principal Cities*

Automate for top performance with . . .

T-J Spacemaker CYLINDERS

Style SM5 shown

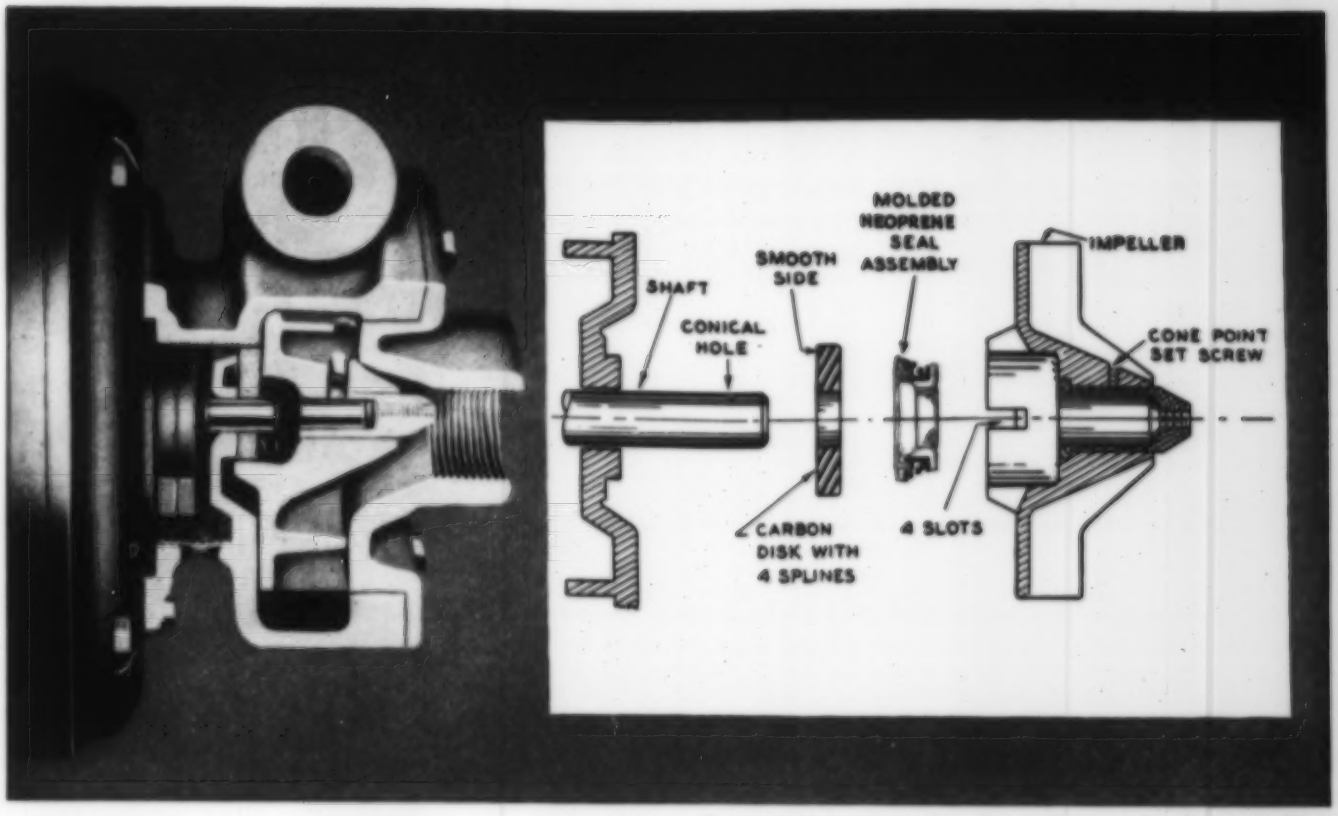
- The Only Cylinders with all the Extras as Standard
- Oil pressure to 750—AIR to 200 P.S.I.
- New Compact Design . . . Saves up to 40% Space
- Proven Performance . . . with Extra High Safety Factor
- Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Hard Chrome Plated Bodies and Piston Rods (Standard)
- Only from T-J can you get these new ingenious cushion designs

More and more of industry's automation problems today—solved with T-J Spacemaker Cylinders! New compact design and many more plus features for a new high in efficient cylinder performance and dependability. Wide range of styles, capacities . . . to help you *save labor, reduce costs* on all kinds of push-pull-lift jobs. Send for bulletin SM-155-1. The Tomkins-Johnson Co., Jackson, Mich.

OFF SHELF DELIVERY

Member of the National Fluid Power Association

T-J TOMKINS-JOHNSON



Courtesy: Pioneer Pump Div., Detroit Harvester Co., Detroit 28, Mich.

Pump seal of DU PONT NEOPRENE

resists chemicals, oil and permanent distortion

Key part in this centrifugal pump is a molded "bellows"-type seal of neoprene, Du Pont's chemical rubber. No packing gland is needed with this resilient seal. Frictional power losses inherent in a packing gland are eliminated, and wear on the pump shaft is minimized. Result: a simpler design, longer pump service life.

Thanks to neoprene's lasting resilience under difficult service conditions, the seal functions perfectly at outlet pressures up to 50 psi . . . never needs adjustments; rarely needs replacement. And neoprene's resistance to oil, solvents and chemicals means long service life in a wide variety of industrial pumping operations.

A carbon disk takes the limited wear that occurs in operation. Four splines in the disk fit into slots in the impeller hub, causing the rest of the seal assembly to rotate with the shaft. Two expanding coil springs press the neoprene bellows against the disk on one side and the machined surface of the impeller on the other, providing a positive seal.

This neoprene seal is another example of the hundreds of applications where neoprene provides the ideal material for a successful design. If a resilient material is indicated in your design, it will pay you to investigate the possibilities of neoprene.

Remember, of all resilient materials, only neoprene has balanced resistance to:

- Oils, solvents, most chemicals
- Permanent distortion
- Air and gas diffusion
- Abrasion, cutting, chipping
- Low-temperature stiffening
- Sunlight and weathering
- Oxidation
- Heat

NEOPRENE

The rubber made by Du Pont since 1932

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

READ "THE LANGUAGE OF RUBBER"—A series of technical articles now appearing in each issue of the free NEOPRENE NOTEBOOK. Mail this coupon . . . add your name to the mailing list today!

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division MD-12,
Wilmington 98, Delaware.

*Name*_____ *Position*_____

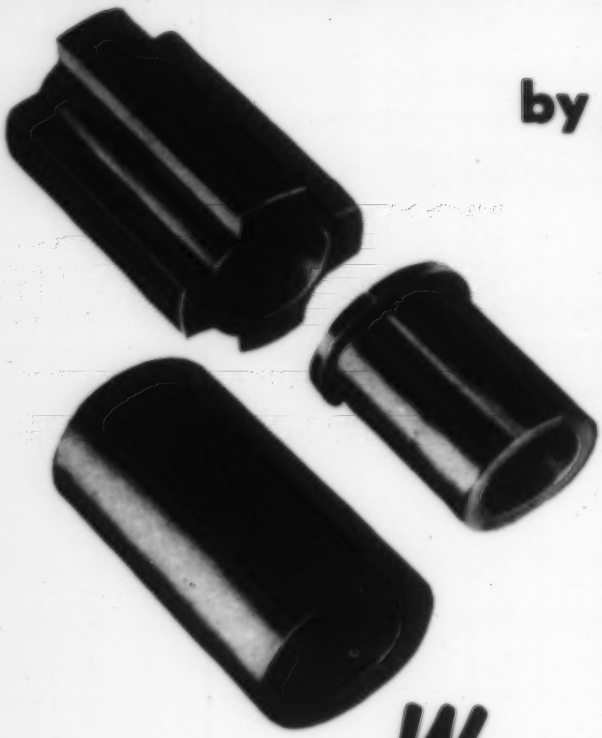
*Firm*_____

*Address*_____

*City*_____ *State*_____

CARBON BEARINGS

by Morganite



- Self-lubricating
- Non-corrosive
- Heat-resistant
- Non-warping
- Self-polishing
- Non-contaminating

Wherever there is a problem in bearing lubrication, high operating temperatures, or product contamination, there is a need to consider the characteristics of Morganite Carbon Bearings.

Self-lubrication is only one of the many unique properties of Morganite Carbon products. It is the most versatile industrial material of our age. Morganite Carbon Bearings, pistons, compressor rings, valves, valve seats, pump vanes, and carbon brushes have contributed successful solutions to many design and maintenance problems.

Morganite Carbon products are recommended for use where oil or grease lubrication could be used only with difficulty, if at all. They can operate in fluids which are corrosive to more conventional materials. And, because of carbon's inert characteristics Morganite's products are exceptionally useful where product contamination is a problem.

Write today for Morganite's Carbon Product brochure. It contains detailed information on Morganite's many carbon products and recommendations for their use. Simply address—

REGISTERED TRADE MARK Morganite INCORPORATED

3302-3320 48TH AVENUE LONG ISLAND CITY 1 NEW YORK

SAMPLE LIST OF MORGANITE PRODUCTS

Steam engine piston rings
Air compressor piston rings
Small pistons and plungers
Cylinder liners
Torque converter seals
Grease seals
Turbo supercharger seals
Water pump blades

Glass molds
Glass cradle blocks
Glass lip turners
Resistor piles
Oxygen seals
Thrust bearings
Gasoline valves

Friction blocks
Clutch discs
Cores for metal castings
Chemical bearings
Gas meter valves
Air compressor blades
Water turbine seals

Kiln car wheel spacers
Supercharger bearings
End plates
Wear plates
Elevator gibs
Carbon brushes
Pure oxide ware:
High temperature tubes

WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT

THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14.

RAYMOND Manufacturing COMPANY
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BARNES-GIBSON-RAYMOND
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B-G-R COOK PLANT
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DIVISIONS OF **ASSOCIATED SPRING** CORPORATION
COAST TO COAST

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THE WALLACE BARNES CO., LTD.
HAMILTON CANADA

BARNES PUMPS ARE DESIGNED

to beat Competition!

ONE SIZE-OVER 15 CAPACITIES . . .
NO BIGGER THAN A MAN'S FIST

- **EXCLUSIVE GEAR TOOTH STRUCTURE** — offers excellent volumetric efficiency even with low viscosity fluids and over a wide temperature range.
- **SPRING-LOADED SEAL** — tight synthetic ring retains any oil getting past leak-back ports in bearings
- **SELF-LUBRICATING** — Self Priming-Fluid being pumped acts as a lubricant for all parts.
- **BUILT-IN RELIEF VALVE** — Simplifies piping — guards against excessive pressures — equalizes fluid pressure throughout.
- **ONE SIZE** — Over 15 different capacities — no bigger than a man's fist — range of gear face widths available to fit capacity demands.
- **PORT, DRIVE SHAFT AND MOUNTING COMBINATIONS** — to fit your exact needs.
- **PRECISION TOOLED** — special mass production machinery holds close limits uniformly. Close limits maintained regardless of temperature changes in fluid due to exact expansion and contraction of material used in both gears and housing.

JOHN S.
BARNES
CORPORATION
301 SOUTH WATER STREET • ROCKFORD, ILLINOIS

EACH standard model of Barnes Pump is available in almost any desirable range of capacities. The capacity of the pump is determined primarily by the width of the gear face — the wider the gear the more fluid it will carry between the teeth. Each gear face size provides a range of capacity based on the operating RPM's. Variation in RPM = 50 to 8,000.

For complete details and sizes available, fill out the attached coupon, and return for complete information.

© 1955 John S. Barnes Corporation, Rockford, Illinois

JOHN S. BARNES CORPORATION
301 South Water St., Rockford, Ill.
Please rush full details on Barnes Hydraulic Pumps.

Name .....

Address .....

City ..... State .....

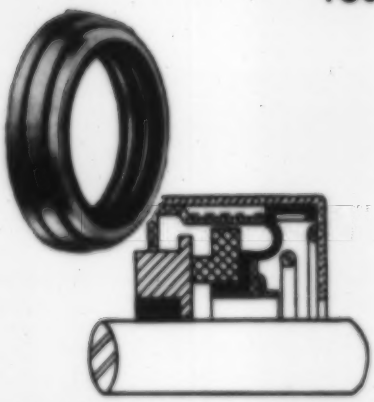
Title .....

Watch for the informative series of John S. Barnes Corporation ads appearing in this publication each month.

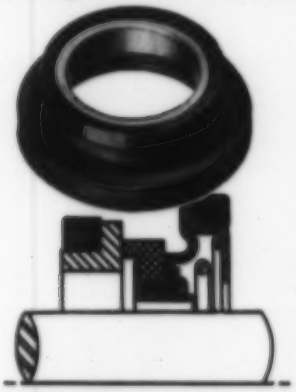
LARGEST STOCK SELECTION AVAILABLE ANYWHERE!

Modern, Mechanical, Face-Type Seals —
Standardized, To Save Time And Money

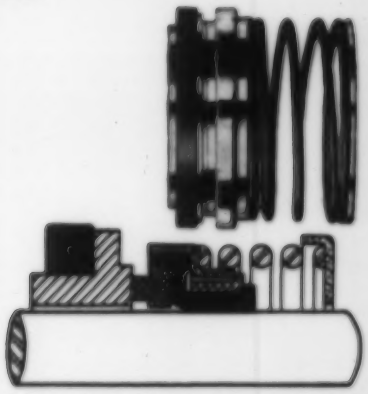
YOUR Sealing Problem Is Solved Here!



STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Important applications in machine tools and power transmission equipment. Stock sizes for shafts .250 through 4.000.

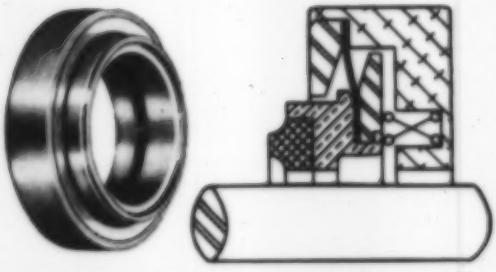


STYLE SGU—A factory-assembled unit-type seal for the small budget user. Widely used in appliance field. Stock sizes for shafts .250 through 1.000.

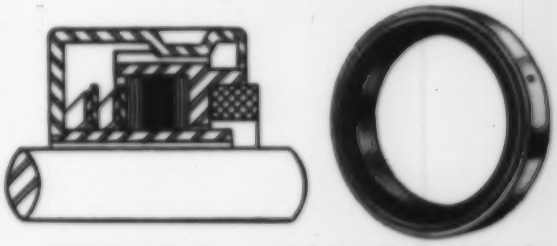


ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Many applications in pumps and compressors. Stock sizes for shafts .250 through 4.000.

STYLE RFO—A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



STYLE DPC — A high-speed, carbon-faced seal, for use where lubrication is poor or where shaft RPM and resulting friction are high. Ideal in many machine tool applications. Stock sizes for shafts .250 through 4.000.



STYLE HH—Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Of particular importance to the aircraft industry. Stock sizes for shafts .250 through 4.000.

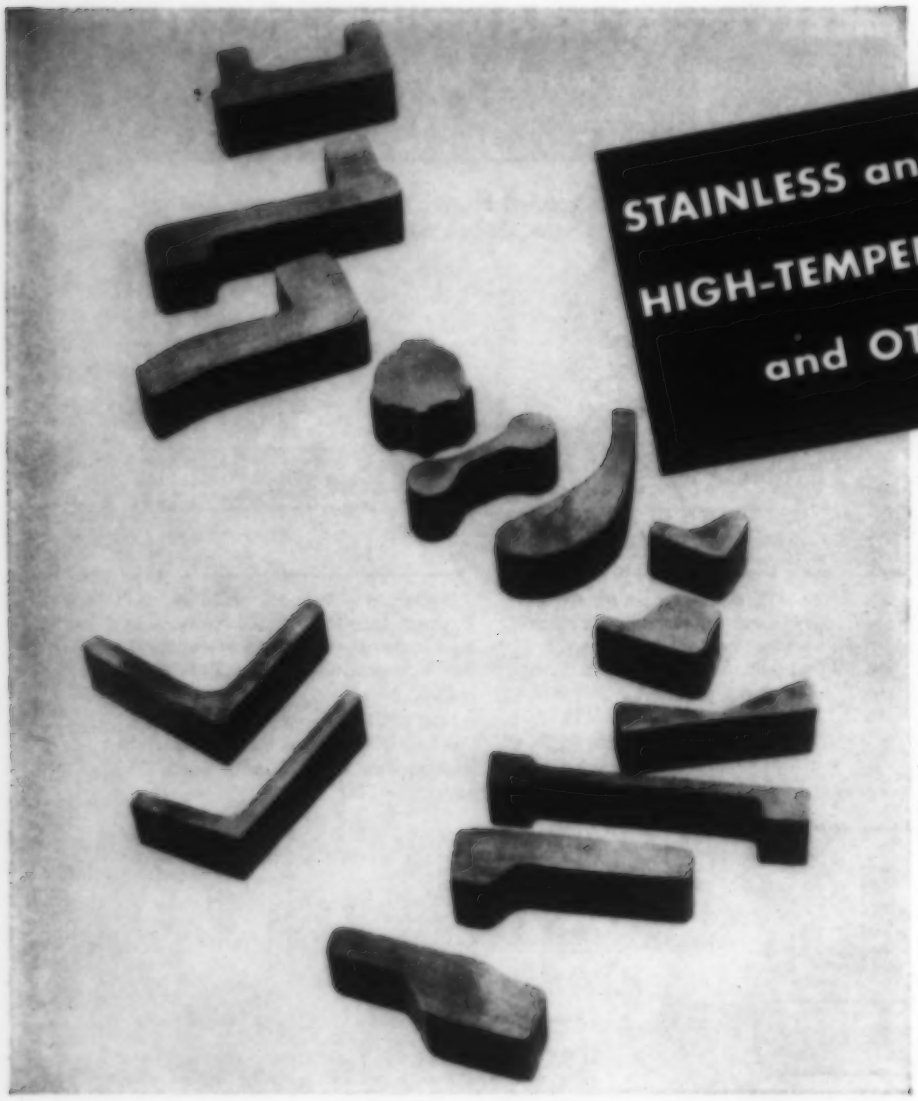
These are only a few of the countless sealing problems now being solved by

GITS SHAFT SEALS

Write for detailed data on any of these
standardized stock Gits Shaft Seals.

GITS BROS. MFG. CO.
1868-A S. KILBOURN AVE. CHICAGO 23, ILL.

Specialists In Lubricating Devices And Shaft Seals For Almost Half A Century



A-L HOT EXTRUSIONS (solid and hollow) may solve problems for you

Help! (Dept. MD-72)

We have a parts problem that hot extrusions might solve. Let's see an AL representative for facts and figures.

- ☐ STAINLESS STEEL
- ☐ TOOL STEEL
- ☐ HIGH TEMPERATURE STEEL
- ☐ OTHER STEELS

Name_____

Company_____

Address_____

Where can these leading advantages of hot-extruded special alloy steels apply to your production?

1. Hot extrusions require very little finishing before use, even in the case of involved shapes. The scrap loss is small and you can buy raw materials closer to finish size. You buy less high-cost steel, cut away less of it . . . save both in time and material cost.

2. The range of shapes, solid or hollow, which can be hot-extruded is almost infinite. They can be easily and quickly produced in any quantity. Dies for new or experimental parts cost little and can be made up fast.

We're ready to serve your needs with hot extrusions in any grade of stainless or high temperature steel, many tool steel grades and other steels. Call us in to help. ***Allegheny Ludlum Steel Corporation, Oliver Building., Pittsburgh 22, Pennsylvania.***

Leading Producer–High Alloy Steels

Allegheny Ludlum

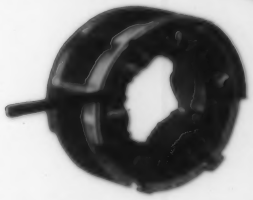
AL TIME-TESTED STAINLESS STEEL

WAD 8318

You will boost sales by teaming your product with Lamb Electric *Super* Shaded Pole Motors. They will give your product the motor advantages of *long life, quiet operation, high operating efficiency, and lasting good appearance.*

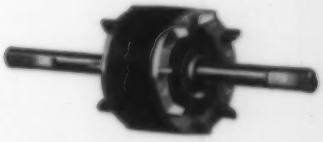
Behind Lamb Electric *Super* Shaded Pole Motors is our 40 years' experience working with manufacturers of household appliances, such as food mixers, sewing machines, floor polishers and vacuum cleaners . . . experience that has resulted in these 10 features:

- "UNI-SPUN" STATOR FRAME for maximum rigidity
- FORMVAR INSULATED WIRE WINDINGS for high strength and insulation resistance
- "AL-SPUN" ALUMINUM ROTOR CAGE for maximum conductivity
- DIE-CAST END FRAMES . . . sturdy, lightweight, corrosion-resistant
- BEARINGS widely spaced, amply dimensioned
- AMPLE OIL RESERVOIR . . . positive oil circulation
- SHAFT precision ground to controlled surface finish
- MOUNTING absorbs vibration
- ADVANCED DESIGN, quality materials, and up-to-date manufacturing methods
- FINISH . . . moisture and abrasion-resistant



"UNI-SPUN" STATOR FRAME

Anchored laminations, ample back iron, strong pole tips mean core rigidity, better heat dissipation, quiet operation.



"AL-SPUN" ALUMINUM ROTOR CAGE

Heat-treated for lowest rotor losses. Integral cooling fan and vented core. Dynamically balanced.

VISIT US at the Air Conditioning and Refrigeration Exposition, Atlantic City, November 28-December 1—Booth 706—or write for folder giving full information.

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

When you've got your eye on the one who will buy, *you use Bonderite under the paint*

BUY-SIGN for people looking for lasting finish...

Bonderite seals, furnished free to Bonderite users, promise "This product will look better longer." Six million will be used this year. Write for information on Bonderite seals for *your* product.

● There are lots of reasons for preferring Parker's corrosion resistant paint base, Bonderite: dependability, over-all economy, quality of product, results and service.

There's another advantage that's *exclusively* Bonderite's: Only Bonderite is known to *your* customer, the ultimate consumer. A quarter of a century of national advertising has established a cause-and-effect relationship between Bonderite-protection and a product that looks better longer.

Yes, when you've got your eye on the one who will buy, you use Bonderite under the paint—and use it to help you make sales.

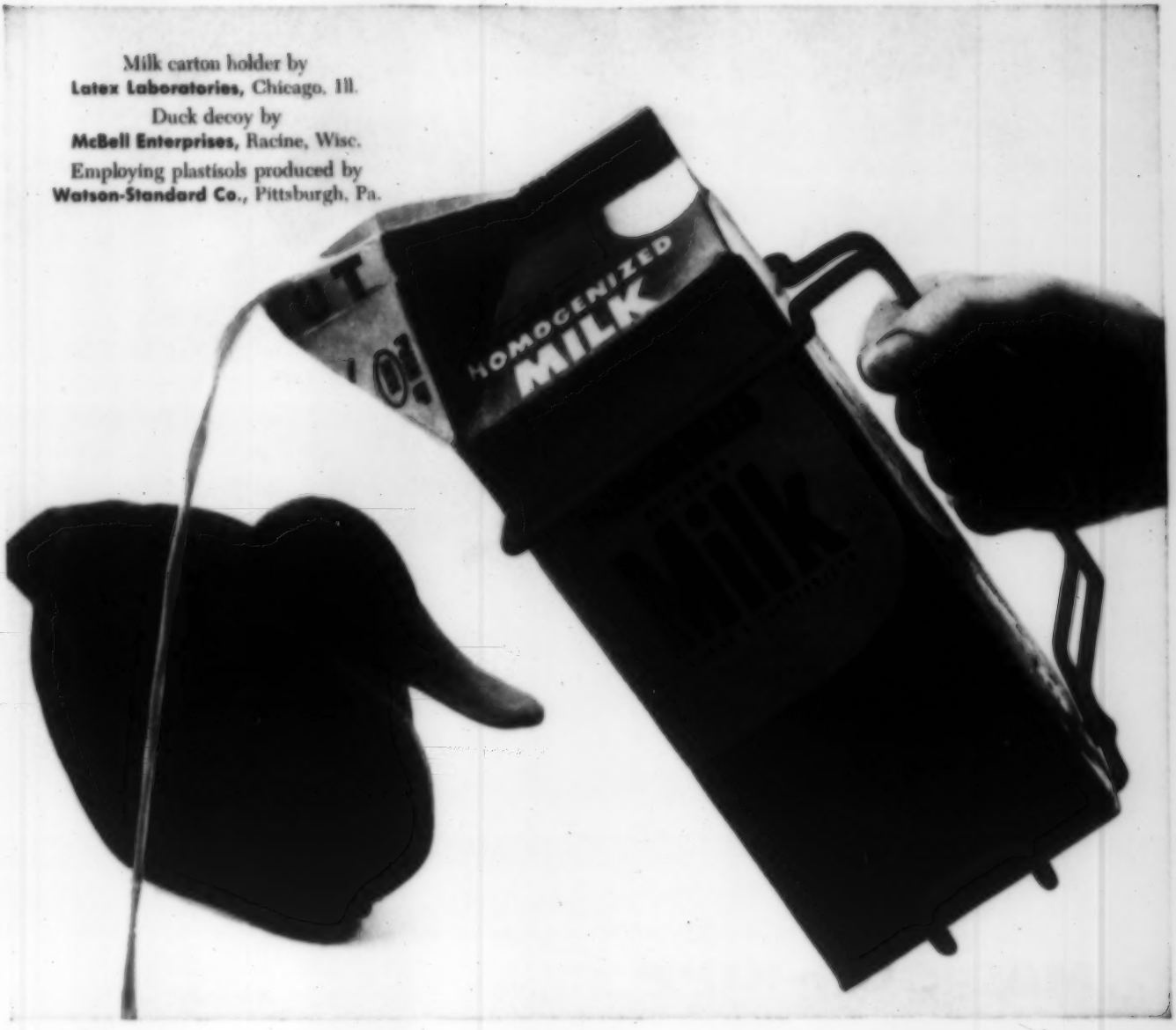
**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U. S. Pat. Off.*

PARKER RUST PROOF COMPANY

2193 E. MILWAUKEE, DETROIT 11, MICHIGAN

Since 1915—leader in the field

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883



Milk carton holder by
Latex Laboratories, Chicago, Ill.
Duck decoy by
McBell Enterprises, Racine, Wisc.
Employing plastisols produced by
Watson-Standard Co., Pittsburgh, Pa.

Product beauty and durability increased ...with PLASTISOLS

Molded duck decoy or dip-coated rack for milk containers—they both *serve* better—*look* better—as a result of plastisols based on BAKELITE Brand Vinyl Dispersion Resins.

Product beauty is enhanced because easy-flowing plastisols can be given almost any color you wish, with either soft or glossy finish. Or, they can be decorated with lacquers based on BAKELITE Vinyl Resins.

Product durability results from the resistance of these materials to water, alcohol, grease, oils, soaps, detergents and most chemicals. Chipping, peeling, abrasion and scuffing is minimized.

Plastisols based on BAKELITE Vinyl Resins are simple and economical to work with—whether you are dip-coating, slush molding or injection molding. They form with little or no pressure and a short bake fuses them into a firm, resilient material. Electrical insulating properties are very good.

For information and technical assistance on plastisols based on BAKELITE Vinyl Dispersion Resins, write Department **KL-103.**

BAKELITE
BRAND
Vinyl Dispersion Resins

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

maximum process utilization

with MADISON-KIPP zinc and aluminum die castings

Die casting as a process has marked advantages in providing lightness, strength and stability in parts that can be cast to dimensions requiring a minimum of machining.

Seasoned skill, however, is involved in getting maximum process utilization as in the Madison-Kipp casting here illustrated, developed with the close cooperation of the user and the die designer.

Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
210 WAUBESA STREET • MADISON 10, WIS., U.S.A.

- Skilled in Die Casting Mechanics
- Experienced in Lubrication Engineering
- Originators of Really High Speed Air Tools

Engineering and Production Men... *Save 3 ways* with Reliance Snap Rings

By milling a groove and inserting a Reliance Snap Ring, engineers and production men have found the economical answer to forming shoulders on shafts or in counterbores. The savings in production TIME can be graphically pictured by comparing the work involved in machining inch after inch of solid metal in contrast to just cutting a groove a fraction of an inch wide. MATERIAL is saved instead of being wasted on the plant floor. In fact, less material is required at the start because standard sized shafts can be used. This all adds up to saving MONEY through efficient production.

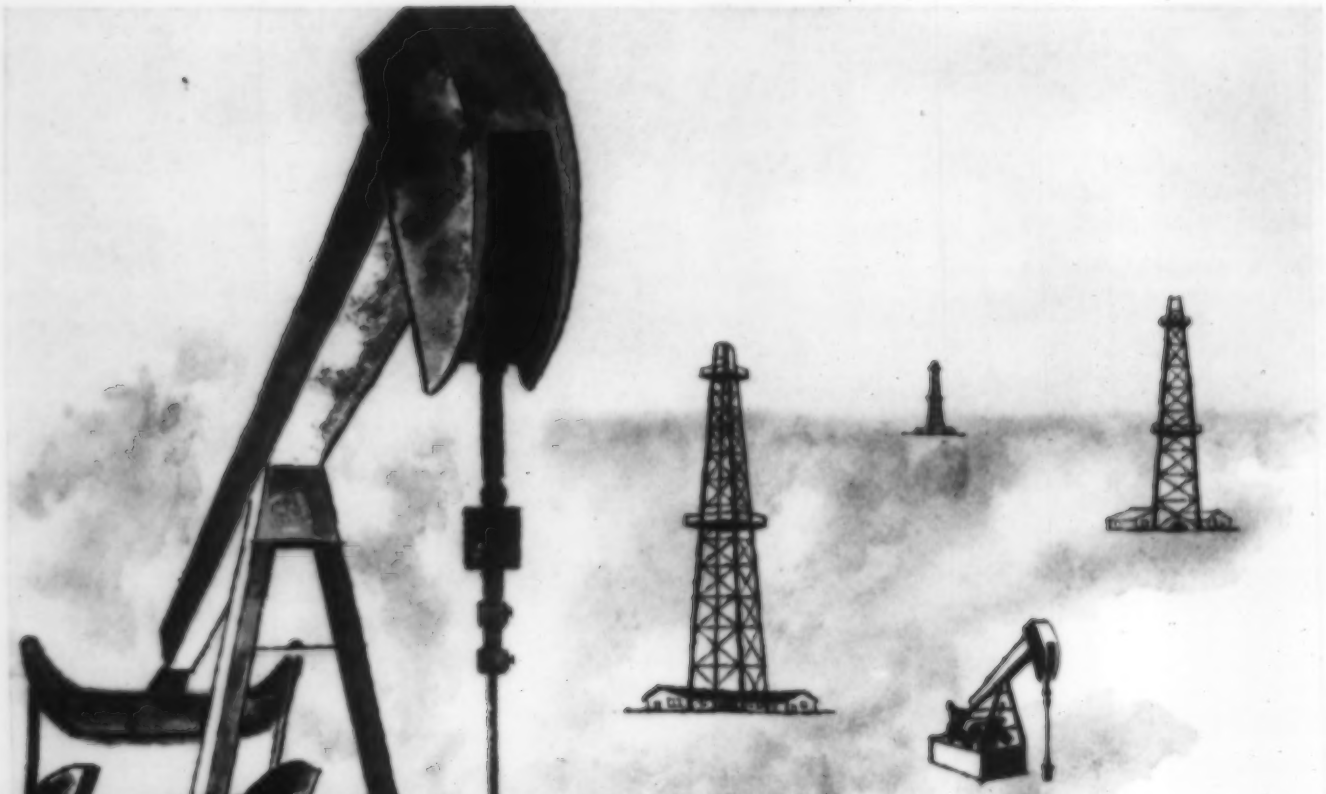
If you would like the complete story on how Reliance Snap Rings can help your operation, write for Engineering Bulletin 4/K3. No obligation, of course.

RELIANCE DIVISION EATON MANUFACTURING COMPANY

OFFICE and PLANTS: 506 Charles Ave. MASSILLON, OHIO

Springitites Snap & Retaining Rings Special Steels Spring Lock Washers Hoo-Ray-Nuts

SALES OFFICES: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal



AMPCO* METAL quadruples life of polished rod liners

Critical part sets new records in tough oil-well service, thanks to Ampco Metal's remarkable corrosion- and sliding-wear resistance

In oil well pumping the 14 to 16-foot polished rod liner really takes a beating. As you can imagine, sliding wear, in this extra-long bushing, is a real problem when you consider the number of strokes made by a pump during an operating day. Corrosion enters the picture, too, with the liner often in contact with salt water, sulfides, etc.

With ordinary bronzes, Cities Service Oil Company found frequent replacement to be a constant headache. Then, in certain areas, it switched to liners made from Ampco Metal Pipe. Cities Service engineers report a substantial reduction in liner replacements.

Ampco Metal Liners last four times as long as plain bronze liners because they are made from a unique aluminum bronze alloy. It's a remarkable bearing material—has unusual resistance to mechanical wear. It withstands the corrosive effects of many acids and caustics. And when used as pipe it combats erosion from solids held in suspension.

Ampco pipe and tubing is available in all sizes, along with a complete line of flanges and fittings. Send coupon today for full information.

*Reg. U. S. Pat. Off.

AMPCO METAL, INC. D-45
Dept. MD-12, Milwaukee 46, Wisconsin

I'm interested in knowing more about the wear- and corrosion-resistant properties of Ampco Metal. Please send me complete information.

Name..... Title.....

Company.....

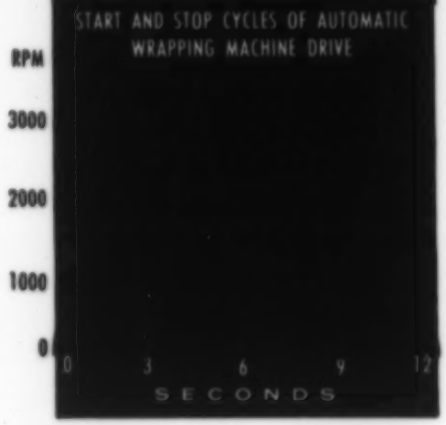
Company Address.....

City..... ( ) State.....

AMPCO METAL, INC.
Sole Producer of Genuine Ampco Metal

Main Office and Plant
Milwaukee 46, Wisconsin
West Coast Plant
Burbank, California

20 ROLLS OF "SARAN WRAP" EVERY MINUTE



The Dow Chemical Company's production of "Saran Wrap" has leaped from 130,000 rolls to 4,000,000 rolls a month since 1951. This up-swing is due to a new plant, a new flow system, and additional equipment including new machinery equipped with Reliance V★S Drives.

One of the most dramatic applications of V★S Drives is on the final wrapping machines shown here. The drives must be able to start, accelerate to 3500 rpm., and stop more than 20 times a minute.

The most important feature, though, is not the frequent starts and stops, but the delicately controlled acceleration of the drives. "Saran Wrap" is only 1/6th as thick as a human hair, and sharp or jerky starts will cause a break in the sheet and halt production. Reliance Drives do the job day in and day out without a single break due to uncontrolled acceleration.

This feature of V★S Drives, called *Dynamic Response*, is only one of the many facets of Reliance Drives. V★S Drives can regulate tension, syncronize operations, control speed rates, and automatically program speed changes.

Whether you handle a thin film of plastic or steel billets, on a complete production line or a single machine, Reliance can give you better quality, more production, and lower costs through Variable Speed Drives. D-1506

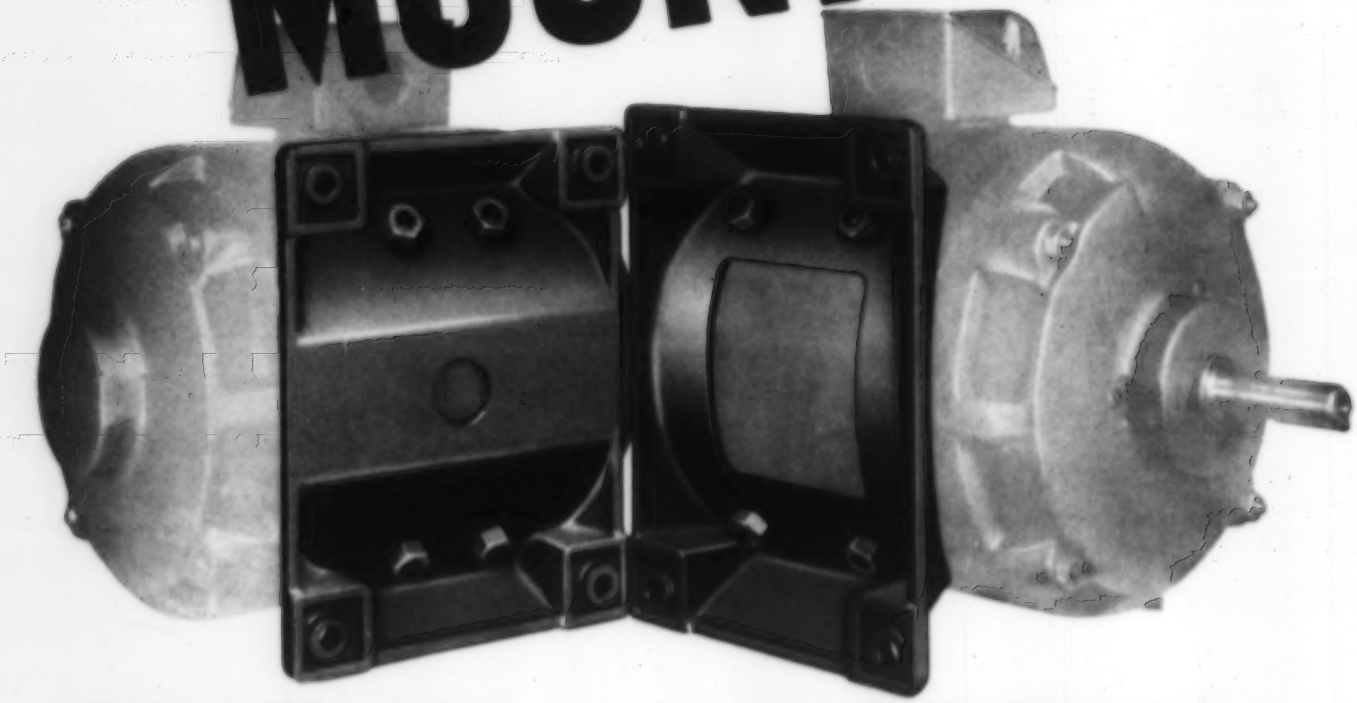
Write for bulletin D-2311.

RELIANCE V★S DRIVE ®

RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 10, OHIO • OFFICES IN PRINCIPAL CITIES
Canadian Division: Welland, Ontario

Optional A. O. Smith FRAME MOUNTINGS



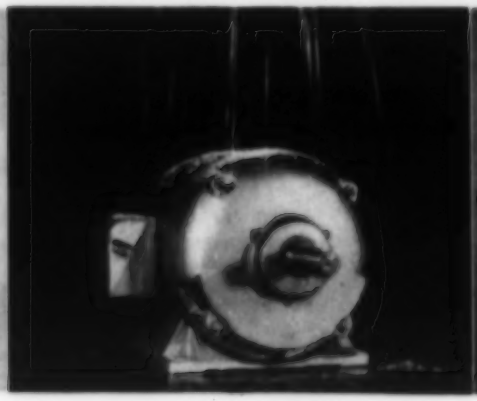
Want to use new NEMA mounting dimensions for integral horsepower motors? Do it with A. O. Smith integrals! Optional frame mountings fit NEMA sizes 182, 184, 213, 215.

Want to keep old mountings but still enjoy all the advantages of new NEMA ratings? Do it with A. O. Smith integrals! Optional frame mountings fit old NEMA sizes 203, 204, 224, 225.

You get these quality A. O. Smith motor features...

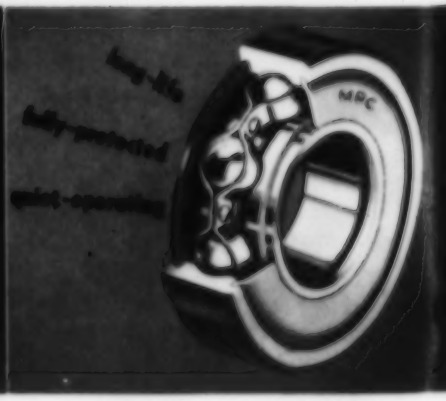
SEALED STARTING SWITCH AND ACTUATOR

Exclusive development . . . totally-enclosed in end frame. No need to remove motor from line for switch service.



DRIP-PROOF CONSTRUCTION

Motor can be mounted in any position . . . drip-proof thru 360° cycle . . . simply rotate end brackets. No foreign matter can enter vent holes.



PRE-LUBRICATED BEARINGS

Shielded bearings assure protection against over greasing . . . provide even load distribution under all working conditions . . . quiet operating.

integral hp motors have

frame mountings to *fit your product specifications*...

with either *new* or *old* NEMA dimensions.

THERE'S no need to change product design or manufacturing processes to enjoy all the advantages of new NEMA specifications for integral hp motors. A. O. Smith offers you motors with optional frame mountings — either the old specifications or the new.

Optional frame mountings for integral hp motors is one of the features used by A. O. Smith in "Application Engineering" motors to your particular design requirements. There's no need to adapt your product to the design limitations of a conventional motor.

Whatever your speed or design requirements, there's an A. O. Smith integral hp motor available to power your products. Integrals are built in single and polyphase . . . in various speeds and frequencies . . . choice of frame mountings for either old or new NEMA dimensions . . . C and D flanges with special flanges as required . . . 1 thru 150 hp.

Produced by one of America's great industrial concerns, these motors are backed by a national network of 270 strategically located factory service stations.

There's one near you — ready to provide 24-hour action on all parts and service orders.

For more information on A. O. Smith integral hp motors, write for new Bulletin No. EM156.

Through research ... *a better way*

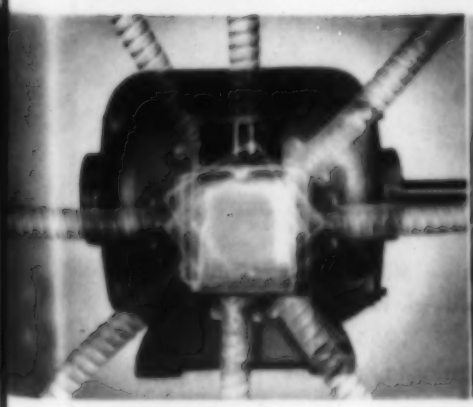
A.O.Smith

CORPORATION

TIPP CITY, OHIO

International Division: Milwaukee 1, Wisconsin

application-engineered to match your product requirements

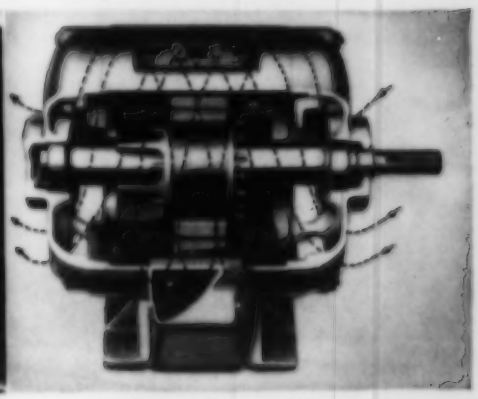


FULL-ROTATING CONDUIT BOX

Can be set at any angle. Designed to save motor space and speed installation. Loosen only three screws to rotate conduit base.

DYNAMICALLY-BALANCED ROTOR

Assures continuous, vibrationless, trouble-free performance and maintains long bearing life. Indestructible laminations are high-quality silicon steel.



CONTROLLED THRU-VENTILATION

Cooling system designed for high-volume, low velocity air for maximum heat transfer. Temperature held to absolute minimum, assuring longer insulation life.

Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

Specify

CASE-HARDENED PLATED CHROME PLATED PISTON RODS

On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. ***Available from Miller at no extra cost.***

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. ***Available from Miller at no extra cost.***

Specify

"TEFLON" WIPERS

On all Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. ***Available from Miller at no extra cost.***

Specify

"TEFLON" HYDRAULIC ROD SEALS

On all Hydraulic Cylinders

Specify

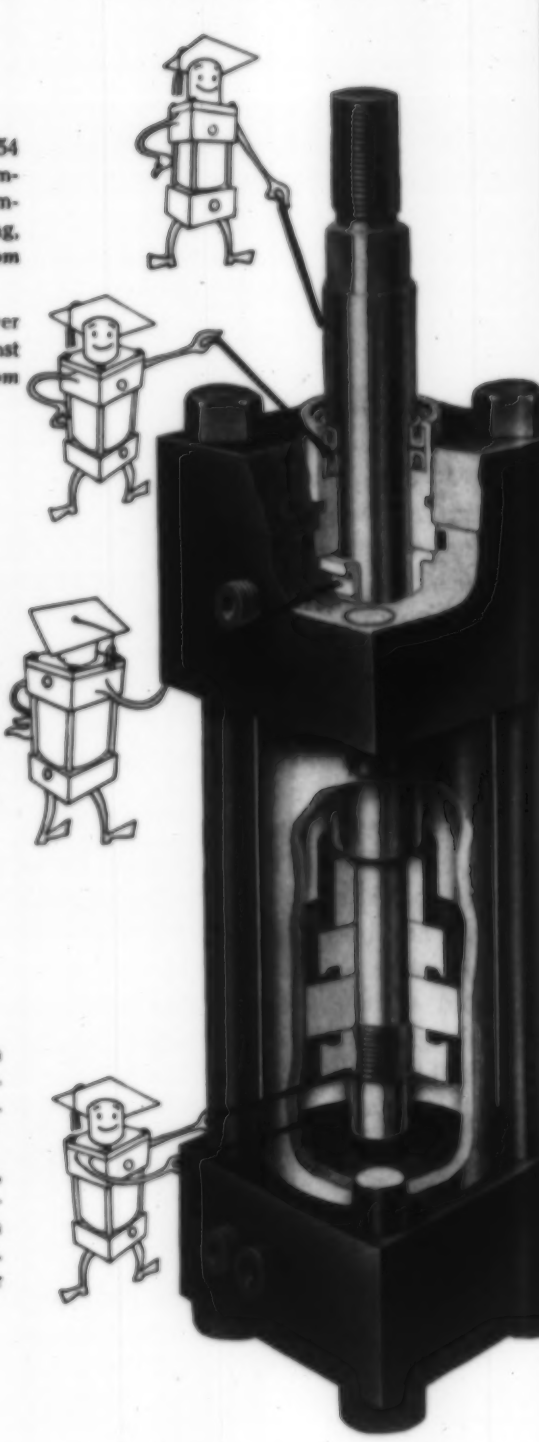
RUST RESISTANT SURFACES

On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish ***at no extra cost on all Miller cylinders.*** (This finish not recommended for water service)



You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.)_____

"On all our future cylinder requirements, please specify the above quality features."

Signed_____

Title_____

EFFECTIVE DATES

These new Miller features will be provided at no extra cost after January 1, 1956—and at Miller's option prior to that date.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • TOLEDO • CINCINNATI • COLUMBUS
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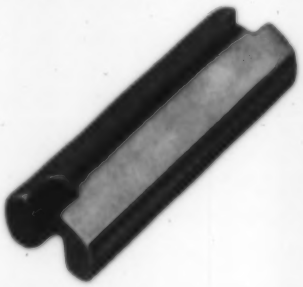
Only the Most Advanced Over-running Clutch Design Can Give You Real Precision

In many applications, precision is required from a clutch. Previously, clutches have been used which fill some requirements, but do not have the precision to insure long life and accuracy. This is no longer necessary. The simplicity of design of Formsprag Clutches is one of the major reasons why really precision performance is delivered.

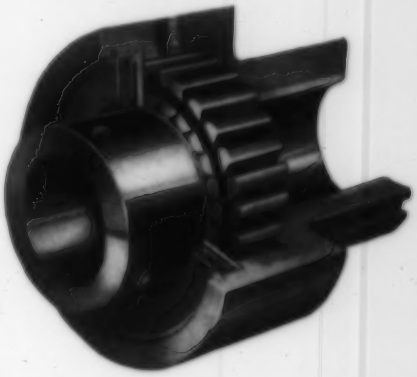
Here's how it works:

It starts with a sprag—



Sprags are an advanced design of precision wedges made of hardened alloy steel. They increase the efficiency—and prolong the life—of virtually every type of equipment using an over-running clutch or ratchet.

A full complement of sprags is inserted in the annular space between hardened and precision ground concentric races. Contact with both race surfaces is maintained by energizing springs.



Torque is delivered from one concentric race member to the other through the sprags. When torque is applied through the driving member, the sprags are instantaneously engaged with no measurable backlash. When torque is removed, all the sprags release instantaneously.

This simple, basic construction, plus careful control of manufacturing, offers you:

- more torque capacity in a smaller space, thus enabling . . .
- higher r.p.m. with less rubbing velocity
- long life
- exceptionally low maintenance

The Formsprag Engineering Staff is experienced in applying clutches to thousands of unusual applications. Their services are available to either apply a standard clutch or design one for your specific application.

A5-12A.

FORMSPRAG *Company*

23603 Hoover Road, Van Dyke, Michigan

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ELECTRIC MOTORS
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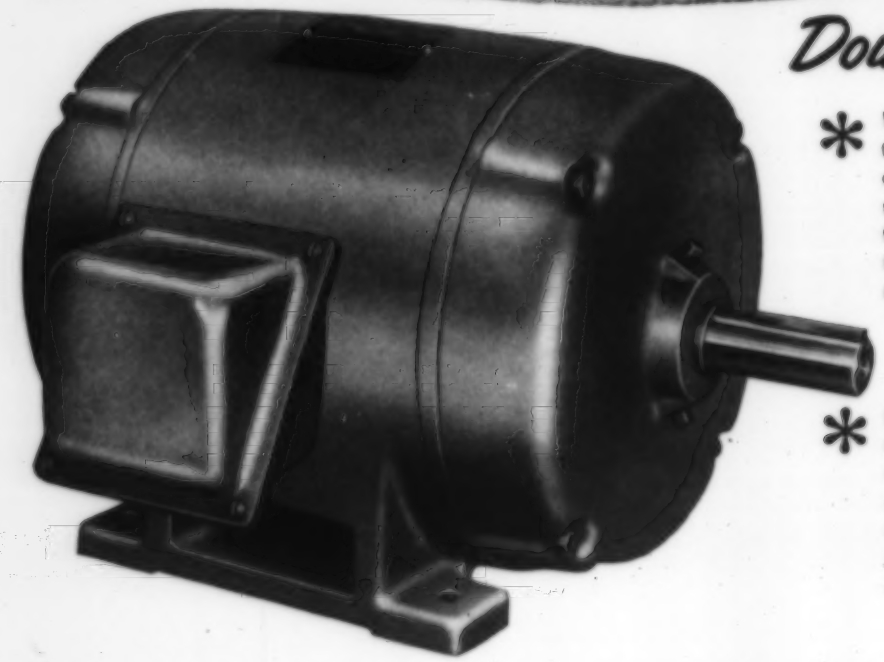
NEW! Wagner Type DP Motors

Doubly Protected



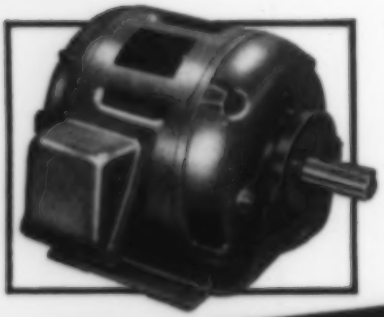
* Wagner Type DP Motors [illegible] protected by rugged, corrosion [illegible] cast iron frames, smoothly [illegible] so that no moisture can collect on them. Motor feet are cast [illegible] integral part of the frame for [illegible] strength and rigidity.

* Enclosures are drip-proof [illegible] intakes are located at the bottom of the endplates – air outlets are located at the base of the frame, one on each side. Specially designed baffles provide protection for the stator windings.

The Wagner line of polyphase, drip-proof general purpose motors—rerated to the new NEMA Standards—pack more power into smaller frames, but give you the same high Wagner Quality and long life performance that have made Wagner Motors "the choice of leaders in industry" for many, many years. These new Wagner Motors are fully protected in the ball bearing models. Their construction makes them completely drip-proof – and virtually splash-proof. The extra large, diagonally split conduit box makes wiring easy. Smaller size and lighter weight means more economical handling and installation.

These new rerated Wagner Motors retain the features desired by plant engineers and maintenance men. They will operate for years without regreasing. But . . . when lubrication *is* necessary or desirable, you *can* lubricate these motors because they are provided with two lubrication openings.

Bulletin MU-202 gives full information—write for your copy today.



AVAILABLE WITH RESILIENT MOUNTING —SLEEVE BEARINGS UP THROUGH 5 HP.

These Wagner standard motors, in ratings up through 5 horsepower, can be used for specialized applications because they are available in sleeve bearing models with endplates that will take resilient mounts.

You can look to Wagner for a complete line of standard motors for specialized applications. The wide range of types and sizes permit the selection of a standard motor for almost any need.

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M53-6

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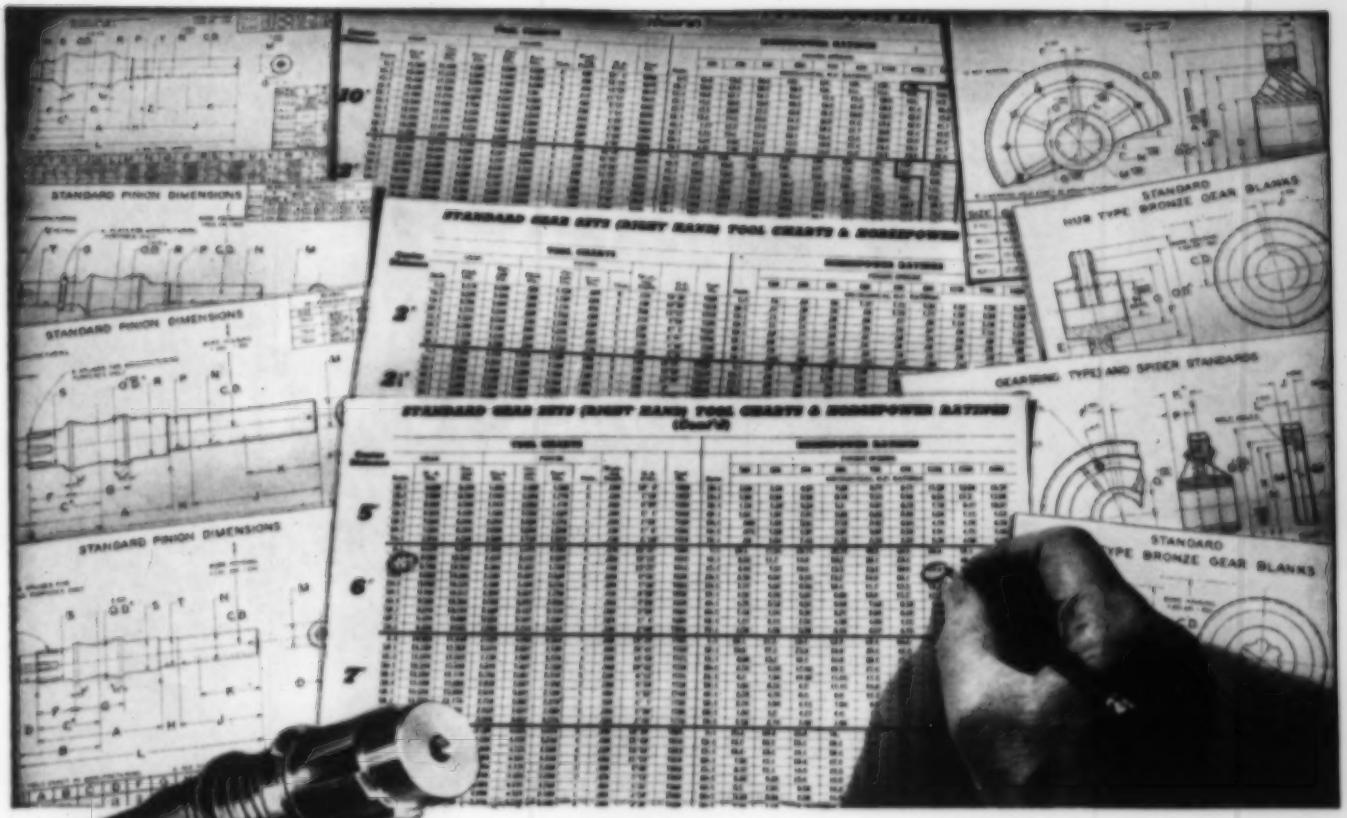
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STANDARD GEAR SETS (RIGHT HAND) TOOL CHARTS & HORSEPOWER
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plus this vital feature

Standard *Cone-Drive gears and worms are carried in stock. Cone-Drive gears are noted for their long life—BUT if a failure should occur at any time, replacement gears and worms are available without delay.*

Ask for Catalog No. 700

Specify STANDARD Cone-Drive Gears and get all these advantages

Lower Cost—due to smaller size of gears and housings, mass production of worm and gear blanks, etc.

Compactness—due to distribution of load over greater contact area, reducing unit pressures. As a result, gear sets can have smaller center distances, enclosures can be smaller, etc.

Less Weight—due to smaller center distances for a given horsepower or torque. Other types of gearing weigh up to 3 times as much for the same horsepower transmitted.

Greater Smoothness—because Cone-Drive gears have more teeth in continuous contact than other forms of gearing.

Wide Range of Sizes—Center distances from 2" to 18" provide horsepower ratings from fractional up to 800 horsepower. Ratios range from 5/1 to 70/1.

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It's more than a sticking process! IPC in laboratory preparation has discovered a special bonding agent which, under proper molding, causes an affinity between rubber and metal.

IPC bonded case seals and bonded washers can be submitted to the most grueling strain. *The bond between metal and rubber will not break down.*

This absolute adhesion is your protection against packing failure. Your problem can be solved by IPC's "custom bond." Write for details, today.

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1. Bonded Washer Seal Double Lip Wiper
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11. Bonded Case Seal Straight Lip Thin Rind Type
4. Bonded Washer Seal Limited Contact Lip
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
5. Bonded Washer Seal Straight Lip With Garter Spring
13. Rubber Covered Bonded Case Seal Straight Lip
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
14. Rubber Covered Bonded Case Seal Limited Contact Lip
7. Bonded Case Seal Straight Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
8. Bonded Case Seal Limited Contact Lip
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

P6

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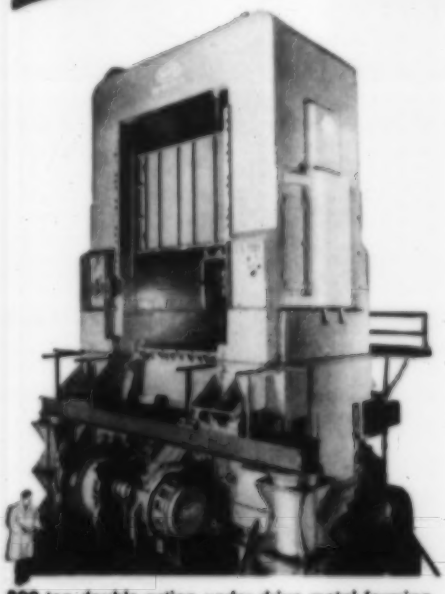
EDDY-CURRENT EQUIPMENT

is Solving Speed Control Problems in Every Major Industry

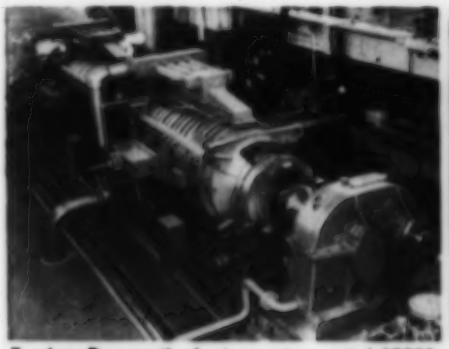


800 ton double-action under-drive metal forming press, driven by Dynamatic model 37-32 combination eddy-current coupling and brake.

In practically all testing, processing, and conveying equipment common to industry, Dynamatic eddy-current rotating equipment is solving a wide range of adjustable speed drive problems, particularly where an AC power source is a requirement.

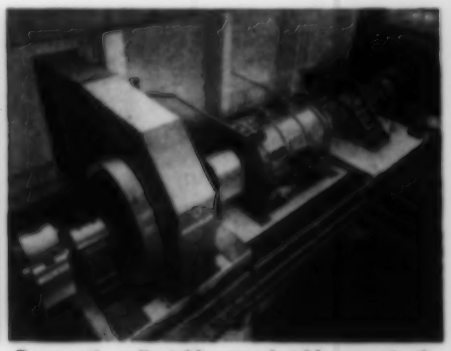
Advantages include rapid response, stepless adjustable speed control, wide speed range, quiet operation, low power loss, low maintenance cost, adjustable speed from an AC power source.

Send for Bulletin GB2, which describes and illustrates the basic Dynamatic eddy-current units, including couplings, brakes, dynamometers, press drives, and Ajusto-Spede® drives.



Tandem Dynamatic dynamometers, rated 20000 H.P., 600 to 5800 RPM. A cradled gear box permits turbine testing to 15000 RPM.

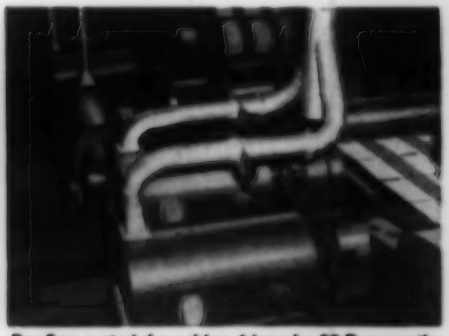
Model WC-1308 Dynamatic adjustable speed eddy-current coupling with eddy-current brake, used as printing press drive. Rated 20 H.P at 1700 RPM.



Dynamatic adjustable speed eddy-current aircraft wind tunnel drive, 18000 H.P. at 480 RPM.

Paper pulp washer driven by Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 125 H.P. at 1100 RPM.

Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 100 H.P. at 1100 RPM, used as cement kiln drive.



Roofing material machine driven by 23 Dynamatic Ajusto-Spede® drives. All drives and controls completely enclosed and force ventilated.

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WHAT THE DESIGNER SHOULD KNOW ABOUT . . . .

. . Adjustable-Speed

ELECTRIC MOTOR DRIVES

by Robert C. Rodgers

- SPEED RANGE
- TORQUE & POWER
- CONTROL METHODS
- REGULATION
- EFFICIENCY
- RELIABILITY
- COST

Adjustable speed is a common requirement in design, but a requirement having many facets. To aid selection and design in this important area, MACHINE DESIGN has presented a comprehensive design guide on "Adjustable-Speed Electric-Motor Drives" . . . the first in a planned series of articles on all types of adjustable-speed drive systems.

It provides practical information for the designer on all electrical methods of stepped or stepless motor speed adjustment:

1. Changing characteristics of electric power input—frequency, phase, voltage—to the drive motor by converters, rectifiers, or motor-generator sets.
2. Changing impedance—resistance and/or reactance—in various sections of the motor circuit.
3. Changing motor design by reconnecting motor windings or by shifting brushes.

It's a design manual that *belongs* in your working library.

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Send me ____ copies of "ADJUSTABLE-SPEED ELECTRIC-MOTOR DRIVES"—at $1.00 per copy.

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Want more casting value per dollar?

Monarch pioneers in casting progress. Our casting and finishing facilities, unique in the industry, produce unusual casting performance. The job your casting must perform is economically accomplished with jobs we perform on the casting.

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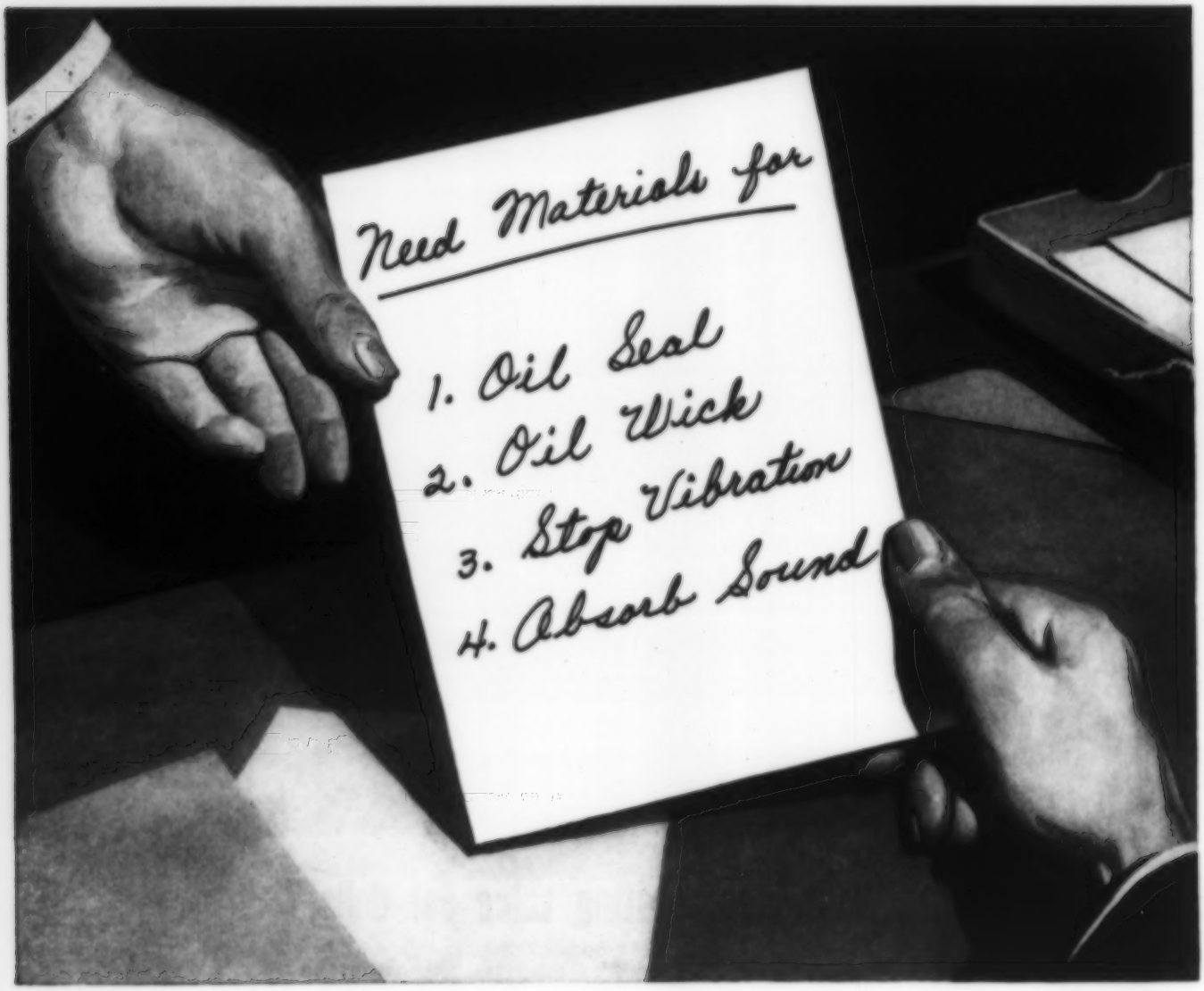

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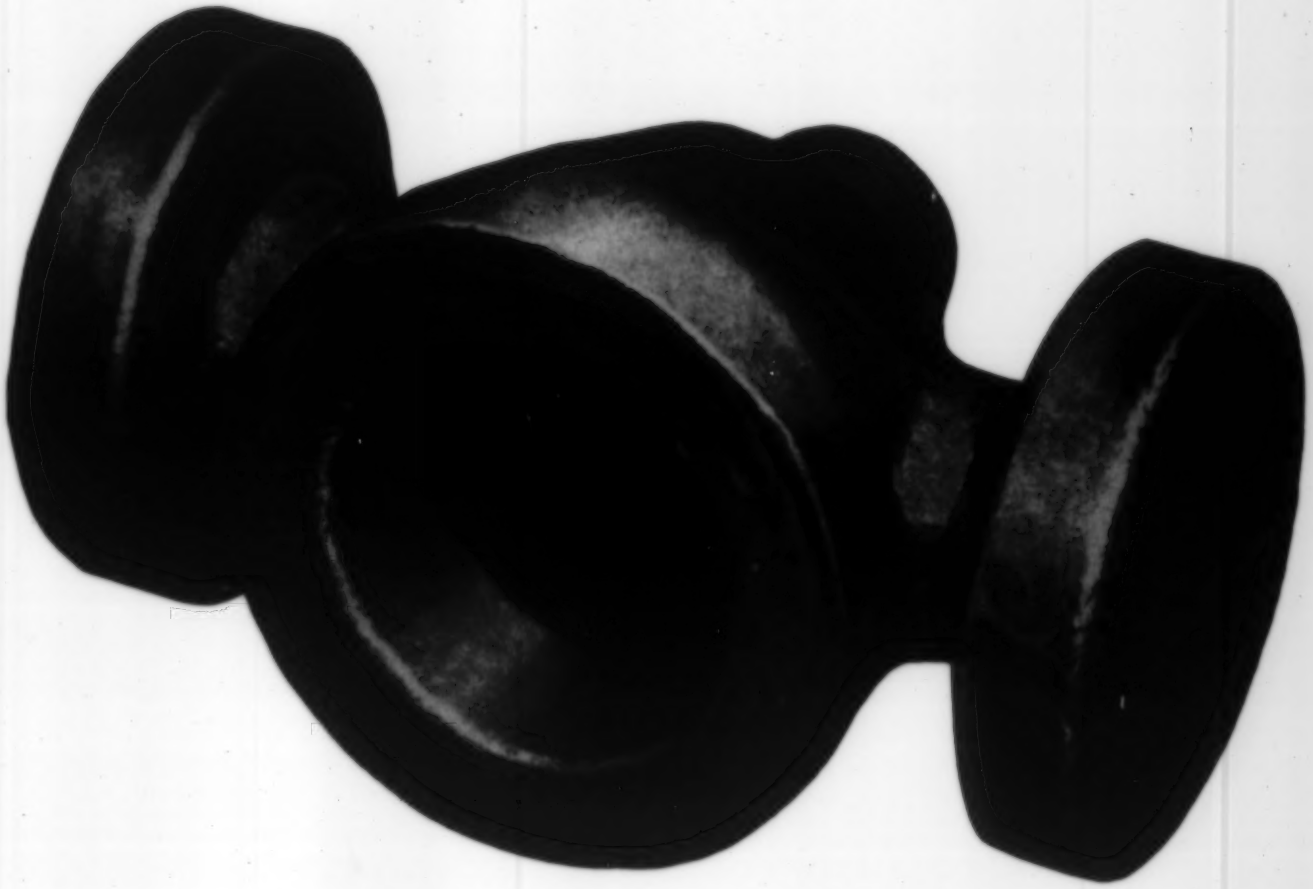


IS THIS A FORGING?

Not too long ago, this large component of high quality steel by necessity, would have been a casting, a fabrication or an expensive machining operation.

Now Cameron's Split Die Forging technique produces this piece as an integral forging with internal as well as external contours in sizes from 200 to 5,000 lbs. Machining difficulties are diminished, strength factors are improved and in many cases cost is reduced.

Maybe your product could be improved or more economically produced by using this type of forging.

WRITE **Cameron**

IRON WORKS, Inc.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas

Case History No. 31 CHAIN BOX

GRAY IRON CASTING

initial cost	$ 9.22
machining	$12.50
TOTAL COST	$21.72

WELDMENT

initial cost	$21.00
machining	$23.50
TOTAL COST	$44.50

GRAY IRON SAVES OVER 50%

The cost of this Chain Box was cut more than half by switching to one, uniform-strength Gray Iron casting. And there are no more welded seams of varying quality to worry about! An important fact, since this chain box is used on rugged road-building equipment. Pattern costs were quickly amortized.

It will pay *you* to look for new, cost-saving ways to use Gray Iron . . . and at the same time obtain the other unique advantages inherent in modern Gray Iron castings. Gray Iron is durable . . . rigid . . . absorbs vibration . . . is heat and corrosion resistant . . . has low notch sensitivity and a wide strength range. It is truly the proved metal that meets modern design needs better and more economically.

For specific technical and business information, write direct to Gray Iron Founders' Society, Inc., National City—East 6th Building, Cleveland 14, Ohio.

This symbol assures you the most for your casting dollar

Here's why it pays to call in one of the more than 500 leading foundries displaying the Society symbol:

- The most recent technical and business information is available to each member through the Society to help you design better products at lower cost.
- The use of sound cost accounting procedures is recommended and encouraged among Society member foundries, assuring full value for your casting dollar.
- Improved castings result from the advanced techniques and the high sense of responsibility of Society members.

MAKE IT BETTER WITH GRAY IRON

GRAY IRON FOUNDERS' SOCIETY

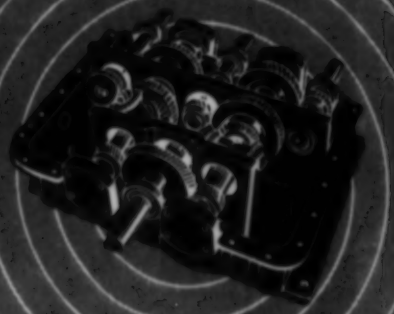
FAIRCHILD
SPEED CONTROL

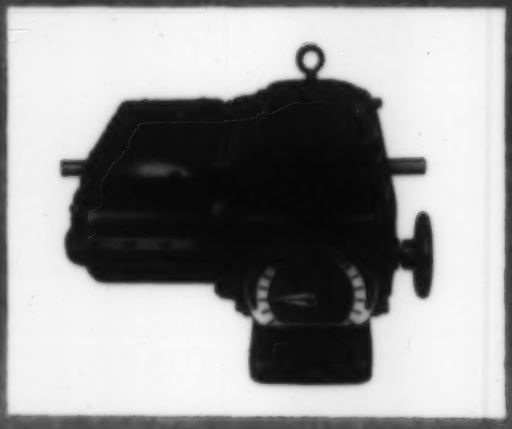
PRODUCTS SOLVE ACCURATE DRIVE CONTROL PROBLEMS

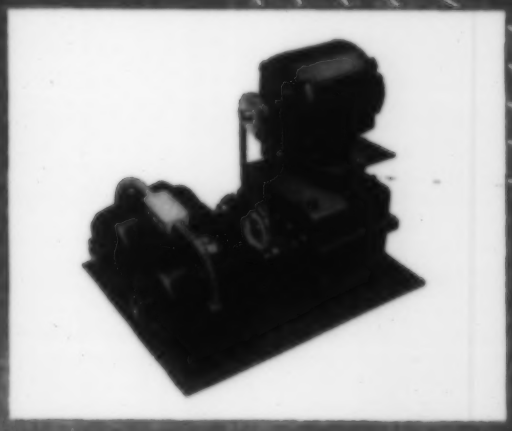
Improved production and quality control in metal, rubber, paper, synthetics, wire, glass and many other fields.

OUTSTANDING FEATURES

- Wide speed range including zero and reverse
- Maximum efficiency and power utilization
- Full torque at zero speed
- Instantaneous response to control signals
- Control simplicity
- Service-free dependability



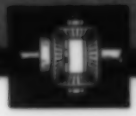




For precision of speed and tension control specify Fairchild Specon products. These compact units provide improved production without the need for costly complex controls. Specon variable speed characteristics enable you to adjust easily for variations in material, build up, shrinkage, gauge differences and moisture content. Highly adaptable, Specon perfected tension control can be tailored to your specifications.

A basic adjunct to today's automated methods, Specon has been adopted by leading American manufacturers. It is available in *Electrical Differential* and *Mechanical Differential* models. Both units, by means of a uniquely designed bevel gear differential, effect optimum speed control through wide ranges *including zero and reverse*. Where extremely close control is required within a narrow speed band, Specon Mechanical Draw transmissions will maintain accuracies of speeds and settings not previously available to industry.

Backed by the technical resources and know-how of aviation's pace-making Fairchild Engine and Airplane Corporation, the Speed Control Division offers advanced engineering in variable speed application. Speed Control will be pleased to analyze your drive problem. Write today to Dept. T.



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BIG BROTHER TO A DENTAL DRILL

"Painless," efficient drilling of primary blast holes in the earth's rock crust—by either percussion or rotary action—is a cinch for Ingersoll-Rand's heavy-duty Quarrymaster. But its greatest advantage lies in the built-in hole cleaner, made possible by using B&W Mechanical Tubing for the drill rod. An automatic, continuous stream of compressed air is forced down through the tubular drill rod to the bit and back up, between drill rod and casing, to the surface, carrying the cuttings with it. And this hollow drill rod has been proved stronger, lighter and more rigid than a solid bar.

To satisfy vital requirements such as long life under extreme conditions of impact, B&W imparted desirable cold-worked properties to this tubing and also devised a special hot-upsetting procedure. With Quarrymasters now in service all over the world, the effectiveness of their drill rods made of B&W Mechanical Tubing has long since been decisively demonstrated.

For a comprehensive story of how B&W Mechanical Tubing serves many industries, ask for Technical Bulletin 361 MD

B&W TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
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TA-5005(M)

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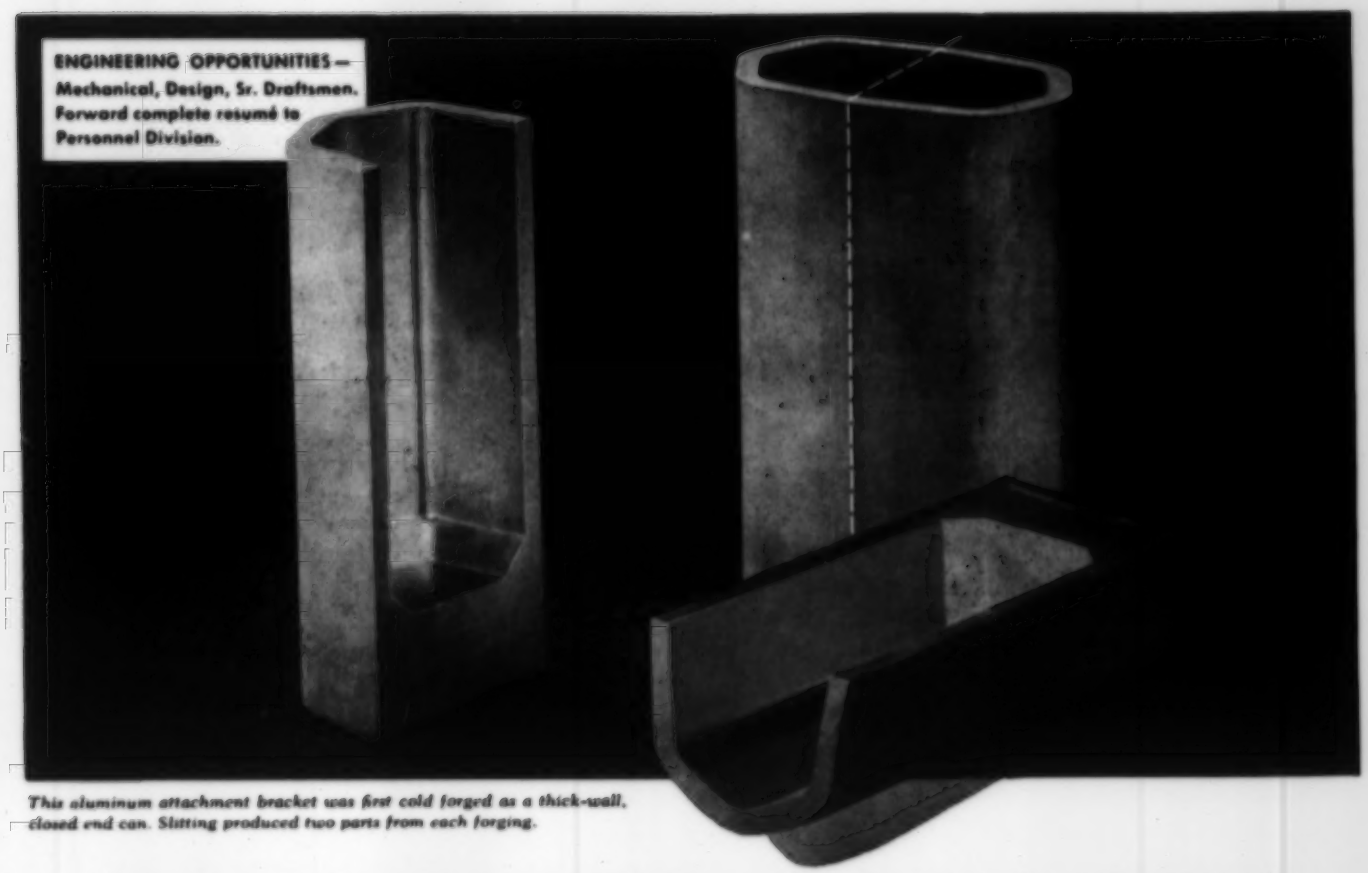
Mechanical, Design, Sr. Draftsmen.
Forward complete resumé to
Personnel Division.



This aluminum attachment bracket was first cold forged as a thick-wall, closed end can. Slitting produced two parts from each forging.

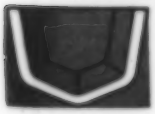
HOW TO DESIGN HOLLOW SHAPES IN ALUMINUM
For Greater Production Economy

A typical example of how Hunter Douglas Aluminum Cold Forgings solve every-day design problems

Throughout industry there is wide use for can-shaped parts—not only as thin-wall cylindrical containers *but in heavy-wall, thick bottom, hollow shapes of varying part geometry which serve a multitude of industrial requirements.* The part illustrated is typical. A series of these act as attachment brackets on an airplane supporting an external wing tip fuel pod.

Because of its special shape, and high strength requirements, three alternative methods of manufacturing are open to the designer.

MACHINING FROM THE SOLID—This part could be machined from bar stock or from an extrusion having correct external shape.

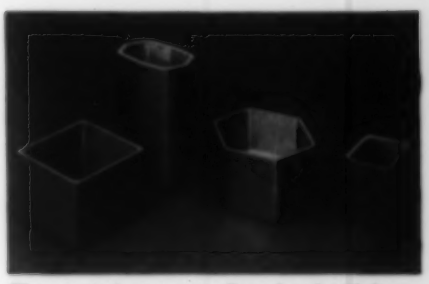


Shaded area indicates metal waste when machining from bar stock. Angled side walls in cavity combined with end detail complicate machining problems.

In either case, the cavity would have to be machined, with considerable difficulty experienced producing correct wall angle with a right-angled end. Both possibilities would be economically limited to relatively short runs.

HOT PRESS FORGING—Correct internal and external shapes can be obtained by hot forging, however, subsequent operations are essential. Draft on both inside and outside faces of the closed end must be removed, as well as any existing flash. Forging die costs are high and a trimming die is also required.

HUNTER DOUGLAS COLD FORGING—*Here is the ideal answer to production of hollow closed-bottom shapes.* By cold forging, both cavity and external geometry are instantly and simultaneously formed. Walls and ends are draft-free and uniformly thick over their respective areas. Being cold forged from a heat-treatable aluminum alloy, desired strength factors with extremely fine, dense, grain structure having continuous unbroken flow lines are obtained. Tooling cost for the cold forging is about half that of a press forging die.



These typical cans were all produced with heavy walls and thick bottoms; were subsequently split making two parts from each cold forging.

Actual cost comparisons between the three methods showed Hunter Douglas cold forgings 39% cheaper than machining from bar stock, 10% cheaper than press forgings.

Hunter Douglas Impact Forgings may hold new possibilities to lower costs and to improved design in your product. For maximum savings, get our engineering analysis *before investing in any other form of tooling!* A blueprint or sample part will suffice.

DESIGNERS:

If you want to know more about Hunter Douglas Cold Forgings write on your company letterhead for this free 40 page book, just off the press!

Hunter Douglas Corporation

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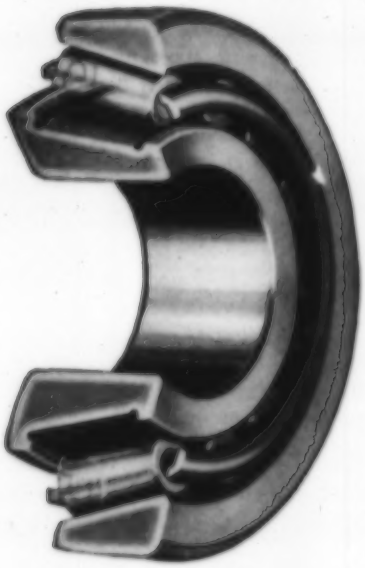
WHATEVER YOUR ROLLER BEARING APPLICATION

specify BOWER!



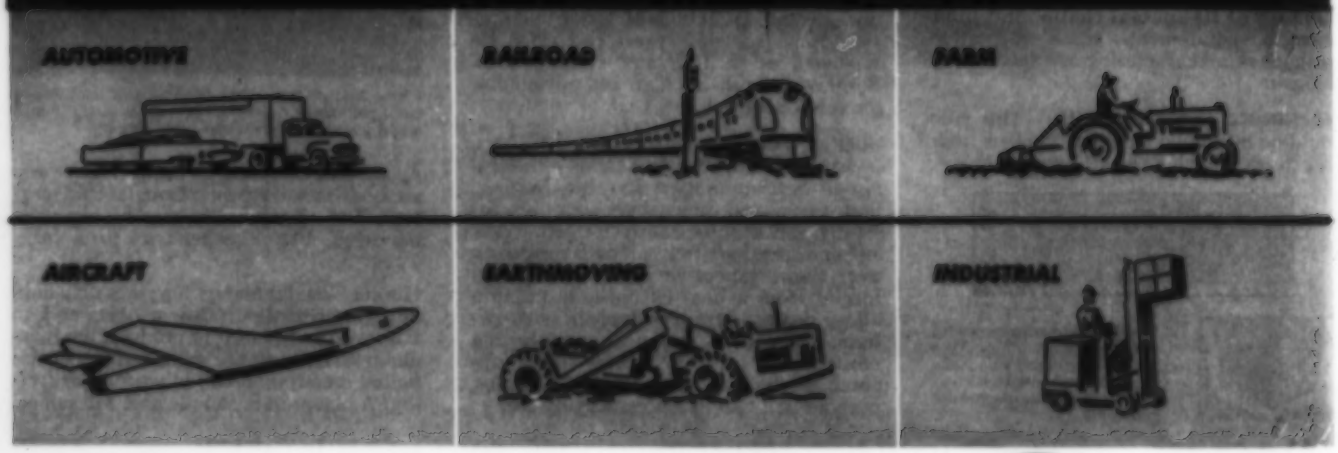
Earthmovers, jet turbine engines, rolling mill equipment, truck axles—you name it! Bower builds a complete line of tapered, straight and journal roller bearings including a size and type to fit *your* product. What's more, these dependable bearings have *proved* themselves in virtually every conceivable type of application. Their built-in quality, skillful engineering and advanced design features provide such important bearing advantages as reduced wear, longer life and lower maintenance requirements. Let a Bower engineer give you full details on the complete Bower line.

BOWER ROLLER BEARING DIVISION
Federal-Mogul-Bower Bearings, Inc., Detroit 14, Mich.

BOWER TAPERED ROLLER BEARINGS INCORPORATE ADVANCED SPHER-O-HONED DESIGN! Spherically generated roll heads and higher flange with larger, two-zone contact area reduce wear, improve roller alignment and virtually eliminate "end play." This helps hold adjustment and pre-load longer and better. Larger oil groove provides positive lubrication.

BOWER STRAIGHT ROLLER BEARINGS ARE BUILT TO CARRY MAXIMUM LOADS! Integral two-lip race increases rigidity—keeps rollers in proper alignment at all times. Steel cage allows free movement of rollers between races during normal operation. High-grade alloy-steel rollers and races are precision-ground for quieter, smoother operation.

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS
for every field of transportation and industry



BOWER

SPHER-O-HONED

ROLLER BEARINGS

Young Heat Transfer News

YOUNG RADIATOR COMPANY, RACINE, WIS.

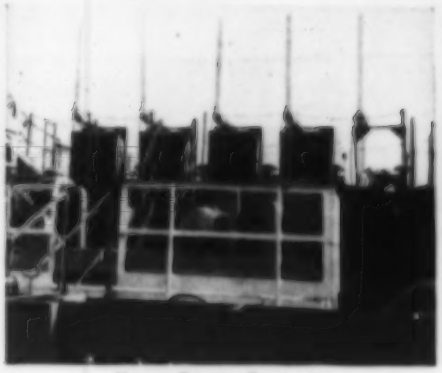
Drill Rig Engine Overheating Relieved With Young Torque Converter Coolers

Like a chameleon, Radiators are ready for just about any climate or condition you can imagine. They'll keep stationary or mobile engines cool in the Belgian Congo . . . or do a whale of a job at Little America.

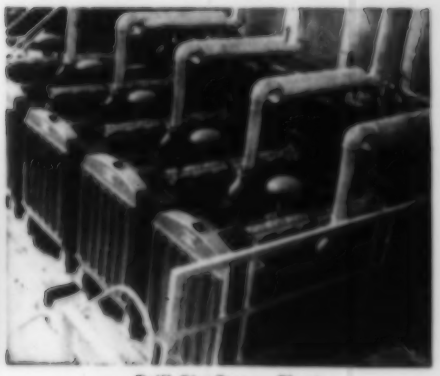
Take a look at all the tools Radiators use to do a real cooling job . . . baffles, by-passes, thermostats, pressure caps, coolants. Then, there are fans, pumps and proven core designs . . . and engineering experience.

Radiator cooling eliminates needless troubles. It does away with engine hot spots, excessive oil consumption, carbon deposits, burned valves and valve seats, stuck pistons and other engine failures.

Don't be fooled by the claims of other types of engine cooling systems. Remember, only Radiators can provide efficient engine cooling under every type of climate or condition.



Young Torque Converter Coolers being installed



Drill Rig Power Plant

COMPLETE RADIATOR, FAN AND DRIVE UNITS FURNISHED BY YOUNG

To prevent overheating of engines furnished on the drilling rig built by the National Supply Company, Torrance, California, five Young Radiator Company Model OCS-450 Torque Converter Coolers were specified.

Past experience with other engine makes had indicated lack of radiator capacity for cooling both engine and converter. On the instance cited, it was felt advisable to provide additional cooling for the Torque Converters by incorporating a converter cooler for this purpose. Engines are rated at approximately 220 horsepower.

Since engines and rigs were built for export, the Young Torque Converter Coolers were selected to secure brazed construction and also to obtain a complete Radiator, fan and drive unit. On the subject drilling rig, the Young Units were added for this purpose. They did not, however, replace any type of radiator.

Front view Young Model 450 Torque Converter Cooler

For more details about Young Torque Converter Coolers, write for free Young Catalog No. 1054 described at left.

WRITE FOR FREE YOUNG RADIATOR COMPANY TORQUE CONVERTER COOLER CATALOG

Completely describes the entire line of Young oil to water and oil to air, Torque Converter Coolers. Illustrates features, cores, mobile and stationary types; dimension drawings, tables and performance charts. Handy sales and engineering office listing provided on page eight for your convenience. Write for Catalog No. 1054, to: Young Radiator Company, Dept. 305-M Racine, Wisconsin.

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RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

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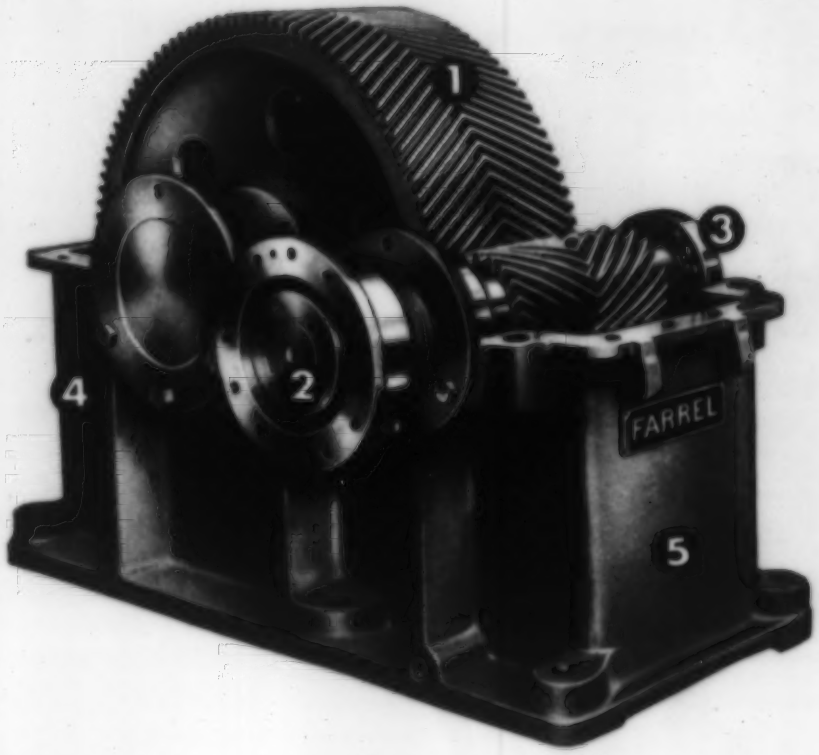

1. **PRECISION GEARS** have teeth generated by the famous Farrel-Sykes method—a process that assures accuracy of tooth spacing, profile and helix angle.

2. **SHAFTS** are large for the power to be transmitted, giving added stiffness against bending and torsional deflection under peak loading variations.

3. **HIGH-CAPACITY ROLLER BEARINGS** take radial and normal thrust loads, hold the shafts in precise alignment.

4. **CONTINUOUS SPLASH LUBRICATION** reliably supplies oil to all bearings and gear teeth.

5. **STURDY HOUSING** holds rotating elements in original alignment, preserves operating smoothness of the gearing.

ABOUT SPEED REDUCER LONGEVITY

FARREL POWER TRANSMISSION MACHINERY

GEARS, CAST—Pattern and Machine Molded, Spur and Staggered Tooth

GEARS CUT—Generated Spur, Single Helical and Farrel-Sykes Continuous Tooth Herringbone Gears from ¼ in. to 20 ft. dia.

GEARS, INTERNAL—Generated Spur and Single Helical up to 18 ft. dia.

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Heavy Duty Drives—Any Size, for Any Application
High-Speed Turbine Units
Special Gear Drives

ROTORS, PUMP—Gear

COUPLINGS, FLEXIBLE — Gearflex, Manger and Special Types

COUPLINGS, RIGID—Flanged and Sleeve

The various design features of a Farrel speed reducer (a few are pointed out above) equip the unit for prolonged service life where operating conditions are unusual and exacting. They protect against down time, too.

The design of a Farrel unit often permits engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements.

Remember, too, that the herringbone design of the gearing in a Farrel unit provides evenly distributed pressure over each tooth, from tip to working depth line. This means that there is no tendency for the teeth to wear unevenly, and shorten gear life.

For more about these long-lived speed reducers, ask for bulletin 449.

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Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Pittsburgh, Detroit, Chicago, Memphis, Minneapolis, Fayetteville (N.C.), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

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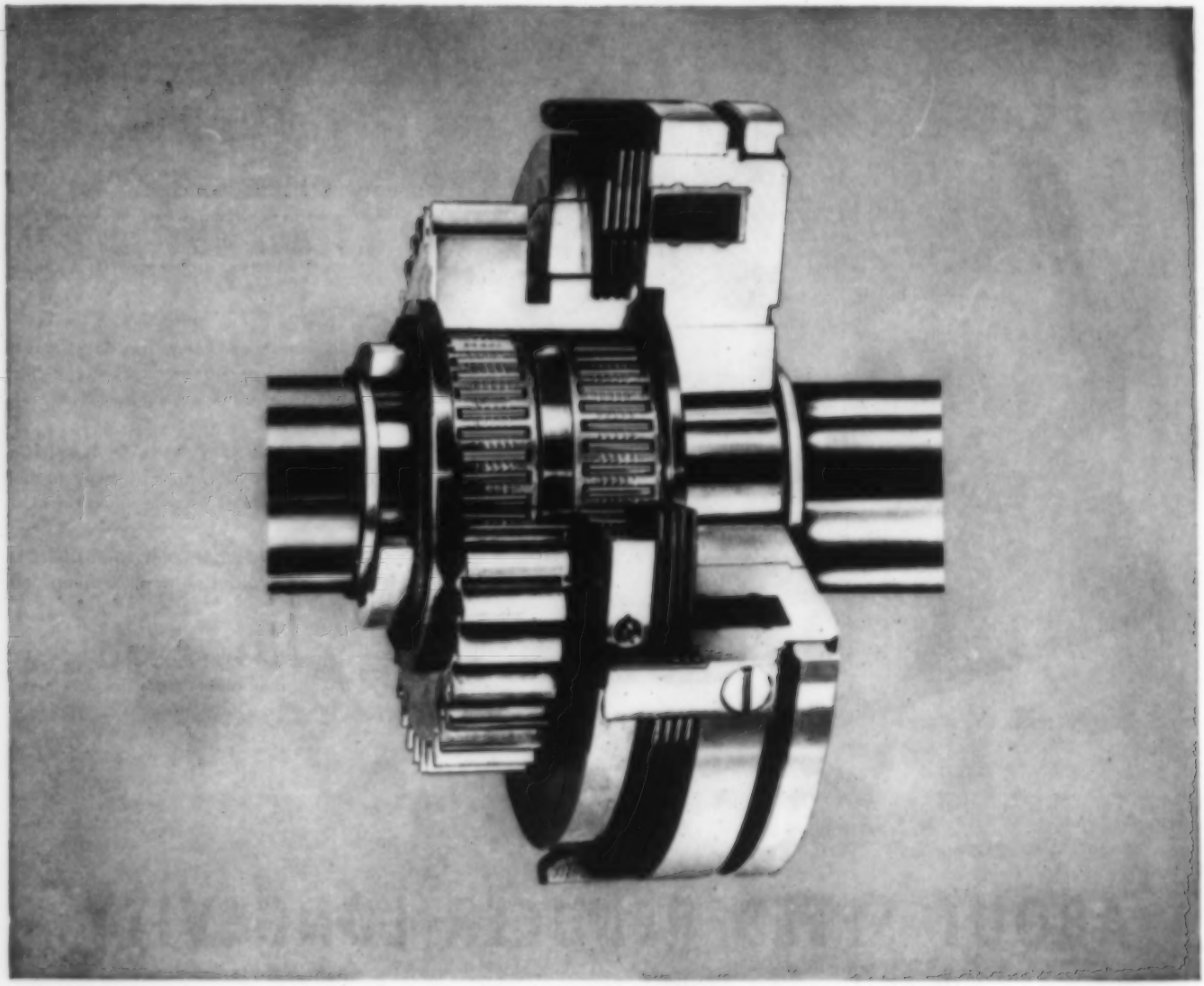

Cutaway of Type "H" Electro Clutch Assembly

Performance Proved*

I-T-E Electro Clutch is positive in action, applies torque fast and smoothly, never requires adjustment

While the I-T-E Electro Clutch is new, it is not untried. Users invariably find that this dependable unit is positive in action, applies torque fast and smoothly, requires minimum maintenance. Extensive load and life tests have proved the advantages of the I-T-E Electro Clutch. More and more, machine tool manufacturers are standardizing on it.

I-T-E Electro Clutch equipped machines can be programmed simply and directly from push buttons, limit switches or relays. I-T-E Electro Clutches are available in ratings from 3.2 to 45,000 ft. lbs. running torque.

Application engineering service is available without obligation. Write for illustrated bulletin. I-T-E Circuit Breaker Company, Transformer and Rectifier Division, 19th & Hamilton Sts., Phila. 30, Pa.

Accepted by major machine tool builders. Names upon request.

I-T-E CIRCUIT BREAKER COMPANY Transformer & Rectifier Division

Gilmer
the original

"TIMING" BELT DRIVE

solves the problem of driving 12,000 RPM vertically-traveling spindle... halves bearing costs!

HERE IS THE VERBATIM REPORT of William C. Shute, Tool and Die Specialist of Cannon Electric Company, Los Angeles, California.

"Over a year ago it was necessary to redesign a semi-automatic drilling machine designed to drill a blind hole in the end of a cylinder having material of yellow brass. This cylinder was to be held vertical and stationary for 66/100 of a second cycle while the drill penetrated the material and withdrew. This indicated a spindle speed of 12,000 RPM and feed of approximately .002" per revolution. To do this successfully and leave a wall thickness of .015" with no bulge or split indicated a drill spindle free to travel vertically without 'play'.

"Because of the tension required on standard 'V' belts to insure positive spindle RPM, *it was impossible to apply the vertical slide method to the drill spindle*, as belt tracking was uncertain with the pulley on the move.

"As the design of the proposed machine provided rocker arm transmission of travel from Cam to Spindle Housing Slide, it was necessary to find a means of power transmission flexible enough to follow the drill spindle pulley through 7/16" of vertical travel and maintain full RPM.

"Whereas the old style machine had given us bearing trouble due to excessive tension on the belts, our new machines with your Gilmer 'Timing' Belts and Pulleys have been practically trouble free. We are using the 390-L-050 (39" circumference Light Duty standard 'Timing' Belt ½" wide) in the horizontal position driving from a 42-L-050 (42-groove, 5.013" pitch diameter 'Timing' Belt Pulley) at 3450 RPM to a 12-L-050 (12-groove, 1.432" pitch diameter) pulley that is stepped up to 12,075 RPM. The upper flange of the drill spindle pulley was removed to allow the operator a quick means of removing the belt and the entire spindle housing for changing a broken or dull drill.

"Now consider this drive, operating in a horizontal position, with only one flange on the small pulley which is turning at 12,075 RPM and, at the same time, traveling up and down 68 times per minute. The belt, itself, is moving at nearly a mile-a-minute, which counts up to a good many miles in an eight hour day. *Our replacement averages one belt every six months if not abused, and this is continuous, around-the-clock service, five days per week.*

"We check these belts constantly and, to my knowledge, in over a year and a half *no motor mount has ever been moved to take care of stretch in any of the eleven machines now equipped with them.*

"Our bearing costs have been cut in half. Also, the bearing life expectancy has been increased over 100% by the use of your belts. 'Down time', the bogy of any production department, has been cut and is no longer an item in replacing worn out belts due to these high speeds."

For more details on this *all-grip, no-slip* drive, contact your local NYB&P-Gilmer "Timing" Belt distributor, or the home office at Passaic, N. J.

Gilmer V-BELTS AND "TIMING®" BELTS

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For extreme operating conditions

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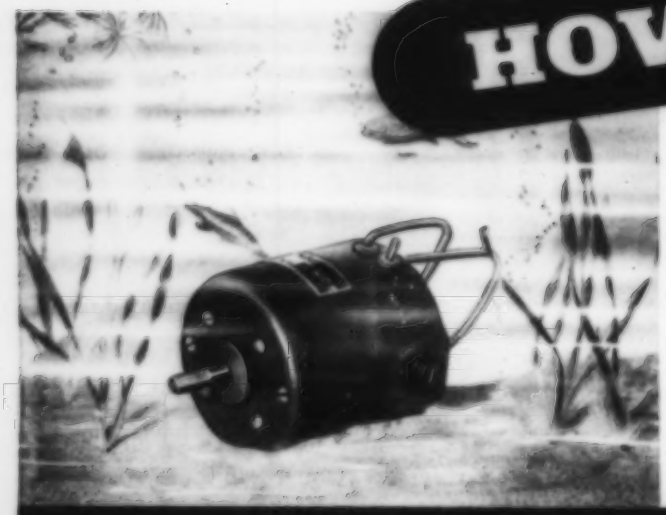
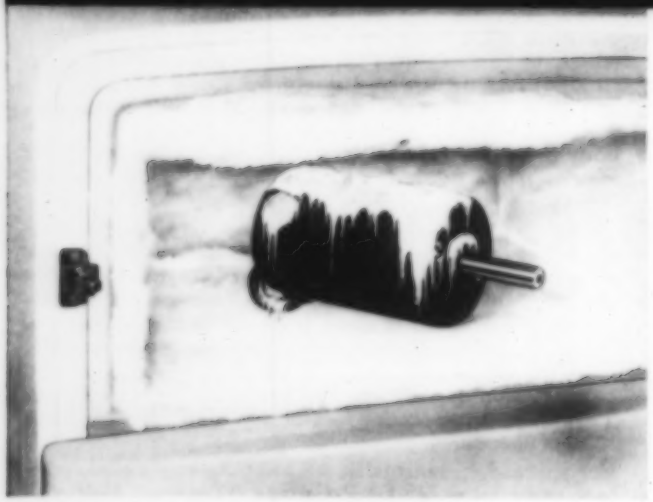
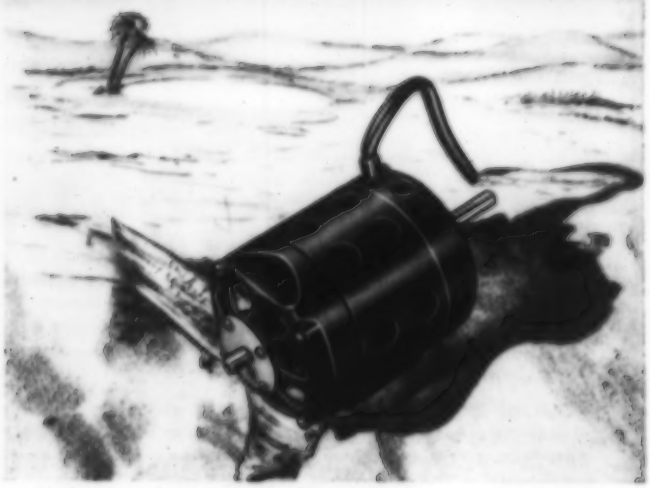


UNDER WATER

AT HIGH ALTITUDES



EXTREME COLD



EXTREME HEAT

Have a difficult fractional h.p. motor problem? Why not check with fractional h.p. motor specialists? Whether it be a problem of waterproofing, altitude, cold, heat, extreme quiet operation, long life or other exacting conditions, Howard has the motor to fill your need.

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If you use fractional h.p. motors in your products, be sure to check with Howard. Write, wire or phone Racine 2-2731.

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Here, in one handy book, is everything you need to know about America's leading oil seals. In 28 pages, fully illustrated, J-M tells you how you can improve performance and cut costs with more effective sealing, longer lasting Clipper Seals.

There are detailed descriptions of all the latest standard seal designs including the new LPD and RPD . . . as well as those for special applications. Uses in petroleum, automotive, mining, earth-moving, aviation, iron and steel, machine tool and process industries are covered thoroughly.

Documented case histories tell how leading manufacturers have profited from the superior performance of Clipper Seals. Full use is made of every type of illustration for complete descriptions of important applications. Close-up photographs show how to install split Clipper Seals in limited space.

Learn how Clipper Seals' many advantages can cut costs for you . . . by simplifying design problems, speeding assembly and providing improved lubricant retention and dirt exclusion under all conditions. Write for free brochure PK-71A to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

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(Advertisement)

A SPECIAL REPORT ON PROTECTIVE FINISHES FOR ALUMINUM

Most aluminum producers and fabricators are well aware of the superiority of chemical finishes over anodizing for the protection of aluminum from corrosion. Naturally, then, there is a running battle for acceptance among the leading producers of the protective chemical finishes.

That's why, here at Allied, we have always studied your needs with regard to both our own and competitive processes. We're constantly trying to produce new and better finishes because we believe there's always room for improvement . . . even to our own products. Some years ago this policy led to the introduction of a process, long in development, that offered you a way to overcome anodizing's obvious technical complications . . . Iridite #14. This finish was far easier to use than anodizing, yet provided comparable, if not superior, quality. And, its cost was much less than anodizing.

But other finishes offering similar advantages over anodizing have entered the market. So . . . the current battle for acceptance. By any cost comparison Iridite #14 is the most economical. However, corrosion tests by users show contradictory results as to performance from Iridite #14 and other leading protective finishes for aluminum. Most tests show Iridite #14 superior, but some do not. The margin of difference, however, is always small. The truth is that all have proved good. However, our laboratory research indicated that still further improvements could be made.

That knowledge . . . plus our aim to give you even better protection and maintain the leadership of the industry, is exactly why Allied Development Engineers have been working for long years to develop a better finish than any of those now available, including our own Iridite #14.

Now the new finish is ready for you. It's called Iridite #14-2 (Al-Coat).

From a performance standpoint, Iridite #14-2 gives you two important advantages in the protective finishing of aluminum.

FIRST: in its fully colored brown film stage it provides corrosion resistance decidedly superior to previous processes.

SECOND: the basic brown film can be hot water bleached to produce a clear-type film with protection heretofore unobtainable from clear-type chemical finishes.

From an operating standpoint, new Iridite #14-2 gives you three important advantages.

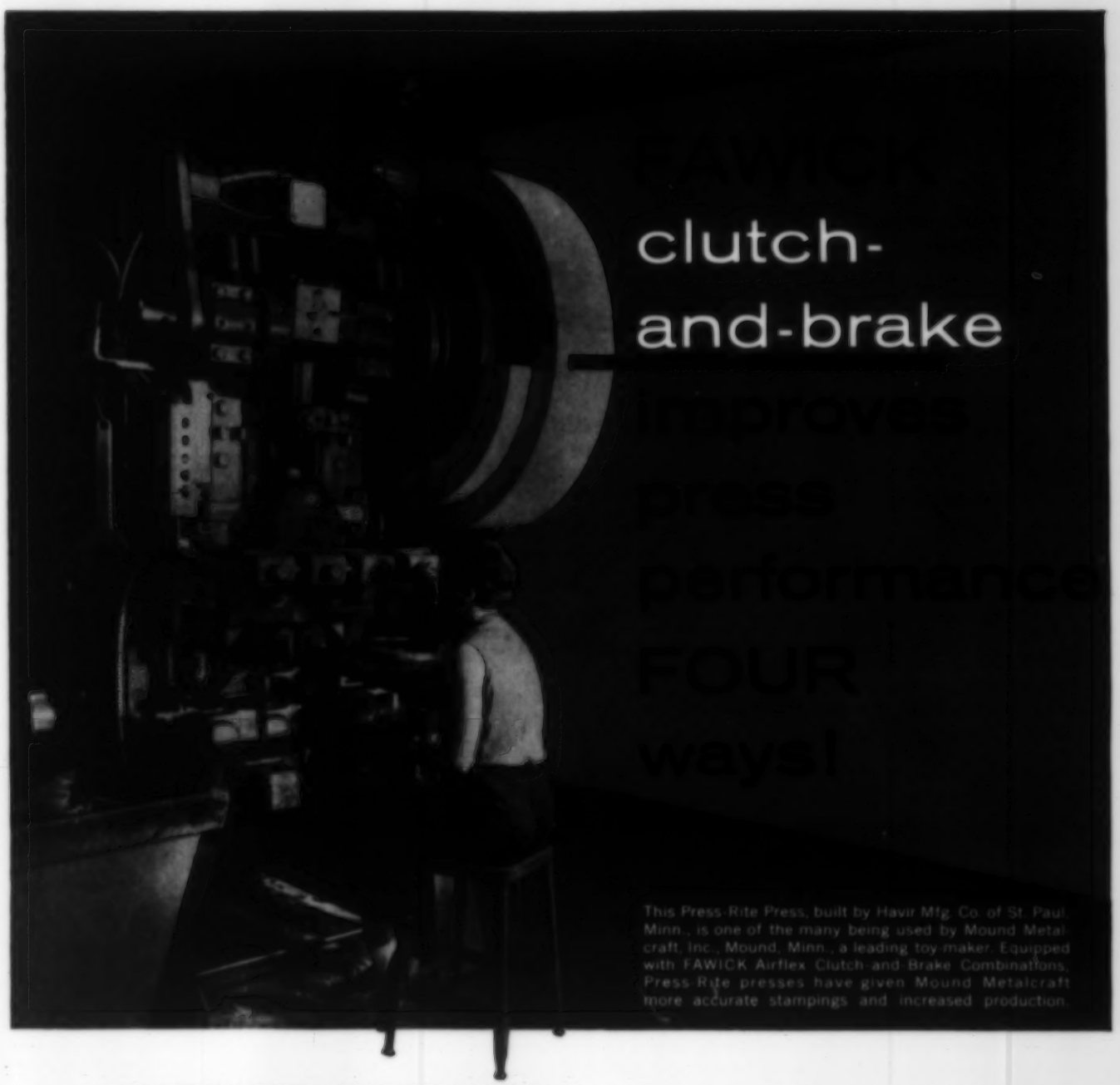
FIRST: it provides consistently higher corrosion resistance for different aluminum alloys treated in the same bath.

SECOND: it provides a more uniform appearance for parts of different alloys and with varied surface finishes before treatment.

THIRD: its operating and technical characteristics are superior to those of other processes.

If you are using or planning to use a chemical finish for aluminum, you should have full details on new Iridite #14-2. Write us or send samples for free test processing. Or, for more immediate advice, call your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book. - - - ALLIED RESEARCH PRODUCTS, INC., 4004-06 EAST MONUMENT STREET, BALTIMORE 5, MARYLAND.

P. S. Even new Iridite #14-2 will be constantly measured against both your needs and competitive processes to make sure you get the best possible, most economical finish for your product that man and the laboratory can develop.



This Press-Rite Press, built by Havir Mfg. Co. of St. Paul, Minn., is one of the many being used by Mound Metalcraft, Inc., Mound, Minn., a leading toy-maker. Equipped with FAWICK Airflex Clutch-and-Brake Combinations, Press-Rite presses have given Mound Metalcraft more accurate stampings and increased production.

1 INCREASED PRODUCTION: FAWICK Airflex Clutch-and-Brake Combinations increase press production by permitting faster operating speed. The combination of the two gives presses better starting and stopping action at higher cyclic speed, permitting more strokes per minute.

2 GREATER SAFETY: Positive action of the air, in engaging the Clutch and releasing the Brake simultaneously, assures complete safety to the operator. In case of air-pressure failure, the Clutch will disengage and the Brake will engage, automatically preventing double stroking.

3 SUPERIOR SERVICE: FAWICK Clutches and Brakes have an exceptionally long service life under heavy-duty, around-the-clock operation. There are no moving parts in the clutch requiring adjustment or lubrication.

4 HIGHER EFFICIENCY: FAWICK-equipped presses produce more and cost less to operate. Production schedules are easier to maintain; there are fewer rejects, fewer lost-time accidents.

FAWICK Clutches and Brakes are applicable to OBI and straight side presses from 15 to 110 tons. Find out how FAWICK can improve the performance of your presses—write or call today. The number in Cleveland is ATlantic 1-2211.

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Hard, dense, molding thermoplastic with high impact, tensile and compressive strength. Resistant to chemical attack, heat and cold. Impervious to moisture, non-wettable, outstanding electrical characteristics. Applications include: terminals, tube sockets and bases, wire and cable insulation, connectors, transistor encapsulation.

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Finely divided plastic solid in volatile medium. Applied by spray, spread or dip coating. KEL-F Dispersions give metallic and other surfaces the corrosion resistance and non-adhesive, non-wettable characteristics of KEL-F plastic. Coating formed is dense, tough, chemically resistant. Applications include: component coatings, dielectric shields, insulation on instruments and apparatus.

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KEL-F Oils, Waxes and Greases are low molecular weight polymers. Resistant to chemicals, heat, cold, and are non-flammable. Oils are fluid at room temperature. Waxes are solid at room temperature. Greases are compounded from oils and filler. Lubricity of oils is equivalent to extreme pressure additive. Applications include: lubrication, hydraulic fluids, heat transfer, damping, potting.

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Highly resistant fluorocarbon elastomer for critical applications subject to corrosive conditions. Possess excellent elastomeric properties, flexibility at low temperature, stability at high temperatures up to 400°F., low moisture absorption. Processed on standard equipment, and can be molded and calendered.

Applications include: seals, valve diaphragms, industrial clothings, wire insulation, microswitch coverings, gaskets, etc.

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Fluorocarbon base printing inks, are resistant to moisture, corrosive chemicals and gases, and abrasion. Produced in range of 10 colors. KEL-F Printing Inks are recommended for striping polyethylene, nylon and KEL-F wire insulation. Combining effectively with the substrate, they offer high performance under difficult conditions.

INVESTIGATE THE KEL-F® FAMILY OF FLUOROCARBON PRODUCTS

KEL-F fluorocarbon products include thermoplastic molding compounds, Dispersions, Oils, Waxes, Greases, Elastomers and Printing Inks. Unique among commercial synthetics they provide the solution to difficult design and production problems when no other materials prove satisfactory.

Based on the extremely stable fluorocarbon molecule, KEL-F products are outstanding for their resistance to chemical corrosion, heat, cold and moisture. Because of their unique combination of properties they can help you make a better product . . . protect equipment against wear or deterioration . . . make possible improved product design . . . meet more rigid performance specifications.

Write for special literature covering your particular interests.

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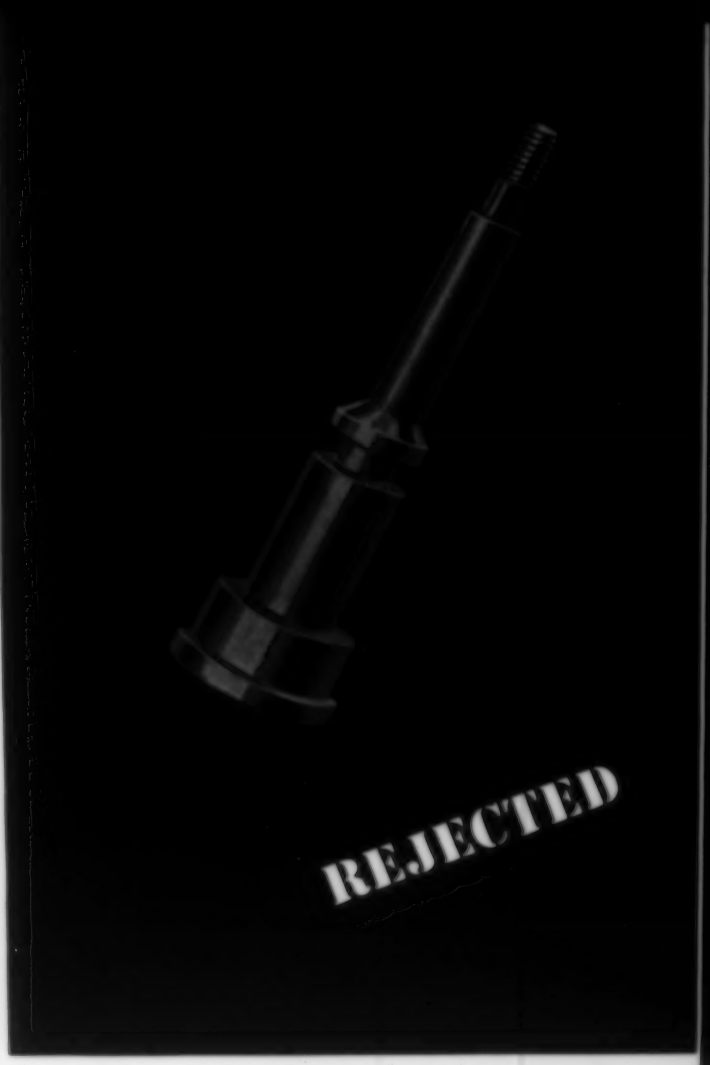


THE DIFFERENCE... *Carpenter* stainless machinability

Here are two reasons why the machining of these seating valves presented a problem in this shop: Tolerances of ± .0005" must be held because they contribute greatly to the operation and service life of the part. Further, the length of the part makes thread cutting on the small end a ticklish operation.

Rejects were running high and costs were excessive when the company was using an ordinary Type 303 Stainless.

Where was the answer? The trouble had to be in the stock . . . yet originally it was thought that the stainless being used would fill the bill. With the trouble at hand, the job obviously called for something better in machinability.

Following this reasoning, the company started to ask questions about easier-machining stainless steels. The answers pointed to Carpenter—originators of the world's first free-machining stainless.

Carpenter Stainless No. 8 (Type 303) was assigned to the job. Now close tolerances are held consistently . . . rejects are considerably reduced . . . and in all other ways the job is a lot easier.

Why be satisfied with "average" stainless steel performance when Carpenter is ready and able to help you? For immediate delivery of the finest Free-Machining Stainless Steels available today, put in a call to your nearest Carpenter Mill-Branch Warehouse or Office. *The Carpenter Steel Co., 120 W. Bern St., Reading, Pa.*

Specify Carpenter . . . the one Stainless Job-Proved to give you:

easier machining
fewer rejects
smoother finishes
lower production costs

Carpenter STEEL

Free-Machining Stainless Steels

IMMEDIATE DELIVERY from local warehouse stocks — Export Address: Port Washington, N. Y. — "CARSTEELCO"

what's your problem?

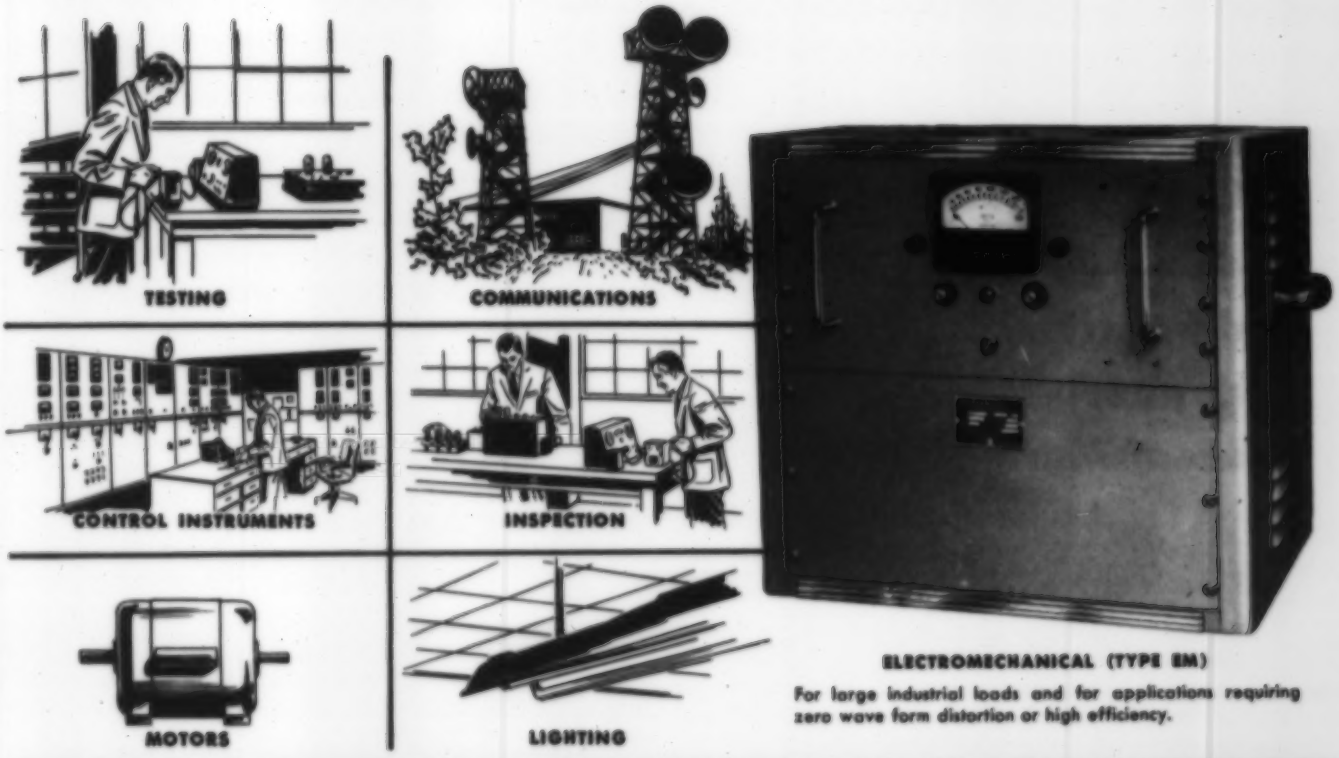
Parts? Finishes? Components? Materials? Maybe one of the advertisements in this issue of MACHINE DESIGN has the answer to your current mental whiplash.

Or maybe the answer is suggested but you want to find out for sure. Why not spend a few seconds right now and get it over with?

Fill out one of the advertising inquiry cards (always *yellow*) and shoot it to us. No letters or postage necessary.

We'll send your inquiry immediately to the advertiser and he will then reply directly to you.

USE THE YELLOW CARDS ON PAGE 33



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For large industrial loads and for applications requiring zero wave form distortion or high efficiency.

STABILINE AUTOMATIC VOLTAGE REGULATORS TYPE EM

Get Zero Wave Form Distortion – with Precise Root Mean Square Voltage Control

When you use *heat, light, sound, power* or *electronic gear,* you need to control voltage to closer limits than it is available commercially.

In thousands of installations the STABILINE Automatic Voltage Regulator type EM has proved itself a rugged "work horse" and an accurate means of maintaining *root mean square* voltage — the rating for which all electrical equipment is designed. Its zero wave form distortion makes it a "must" for many types of electronic equipment. Its efficiency is comparable to fixed-ratio transformers.

STABILINES type EM are available in 115, 230 and 460 ratings for single and three phase duty in capacities up to 100 KVA with correction speeds from .075 to .32 seconds per volt. Send for bulletin for full details.

See Superior Electric's Mobile Display when it is in your area

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½ actual size

ELIMINATES INTERLOCKING SWITCHES AND COMPLICATED ACTUATING DOGS

Ideal for pulsing solenoid valves on air-hydraulic controls, sequencing circuits, etc., because it allows other controls to reverse or operate the same circuit. Switch sends a short electrical impulse and then switches itself out of the circuit.

GIVES MORE DEPENDABLE CONTROL

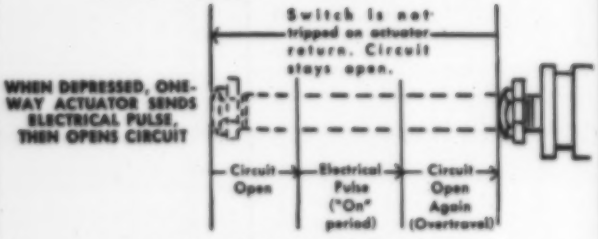
Switch replaces timers, relays, and troublesome one-way dogs to simplify circuits — cuts chances for failure. No delicate adjustments.

LOWERS COST OF CONTROL CIRCUITS

Impulse switch costs less than complicated control devices it replaces. Fewer switches are required for sequencing. Simple mounting.

SPEEDS UP AUTOMATIC OPERATION

Automatic machines can run faster because cycles can be more closely sequenced. There's no delay due to timer tolerances or extra machine motions to actuate interlock switches.


Switch is not tripped on actuator return. Circuit stays open.
WHEN DEPRESSED, ONE-WAY ACTUATOR SENDS ELECTRICAL PULSE, THEN OPENS CIRCUIT
Circuit Open
Electrical Pulse ("On" period)
Circuit Open Again (Overtravel)

SPECIFICATIONS

UL rated at 10 amps/125v AC Movement Dif. 0.020"
Operating Force 3½ lbs.

Model No.	Overtravel	"On" Period (inches of actuator travel)
ES4-KM1	3/8"	1/16"
ES4-KM2	5/16"	1/8"
ES4-KM3	1/4"	3/16"
ES4-KM6	1/16"	3/8"

TRY ON YOUR CONTROL JOB — ORDER NOW

Send Your Standard Purchase Order
Specify Model Wanted—Discounts on Quantity Purchases

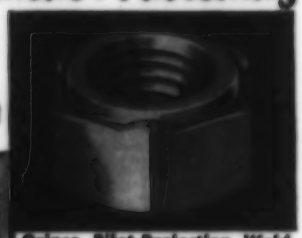
ELECTRO SNAP

ELECTRO-SNAP SWITCH & MFG. COMPANY
4214 West Lake Street, Chicago 24, Illinois

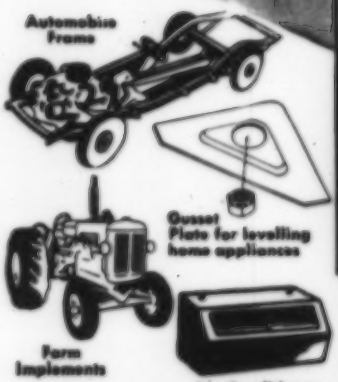
WHEN YOU NEED *Quicker Fastening*

FOR
- Blind Assemblies or
- Extra Threaded Depth at less cost...

use one of these 2 WELD NUTS



Gripco Pilot-Projection Weld Nut. Circular pilot designed for quick, easy positioning of nut over bolt hole for instant resistant welding. No jigs, no fumbling, no waste of time. Furnished with or without famous Gripco locking feature.



Gripco Countersunk Weld Nut. Eliminate time-wasting retapping of nuts after welding. Exclusive countersunk nut bottom does away with fouling of nut threads by weld spatter. Available with or without Gripco locking feature.

Write for sample and full details. BD. 118

GRIP **NUT COMPANY**
310 W. S. Michigan Ave. • Chicago 4, Ill.

MARSH MAKES IT!

If it's a pressure gauge or dial thermometer, Marsh makes it . . . and makes it better. The types, ranges and case styles are endless. What is "special" to other instrument makers is often standard to Marsh. To know the scope of Marsh instruments—

Write for this fact-filled catalog

MARSH INSTRUMENT CO. Sales Affiliate of Jas. P. Marsh Corporation
Dept. B, Skokie, Ill. • Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton Alberta • Export Dept., 3501 Howard Street, Skokie, Ill.

WHAT IS THE PROPER AMOUNT OF TENSION TO APPLY TO A BELT?

Notwithstanding the many factors involved, it can be summed up in a few words as THE MINIMUM TENSION NECESSARY TO TRANSMIT THE REQUIRED POWER WITHOUT SLIPPAGE.

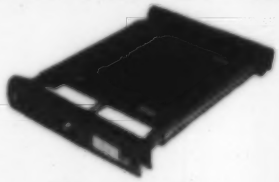
WHY THE MINIMUM?

Because more avails nothing, and EXCESSIVE STRESSES ON BELTS AND BEARINGS MATERIALLY SHORTENS THEIR LIFE.

The Proper Tension can be had, and maintenance reduced to a negligible quantity by mounting the motor on a Tension-Controlling AUTOMATIC BASE. Micrometic adjustment for the Proper Amount of Tension is made while operating under load, merely by turning a screw. Not a bolt or nut is disturbed. Nothing could be simpler, and there is nothing more accurate.

The AUTOMATIC BASE can be mounted in any position, and the motor pulley may rotate in either direction.

WHY NOT PROVIDE THE "MISSING LINK" BETWEEN THE MOTOR AND YOUR MACHINE BY USING AN AUTOMATIC BASE?

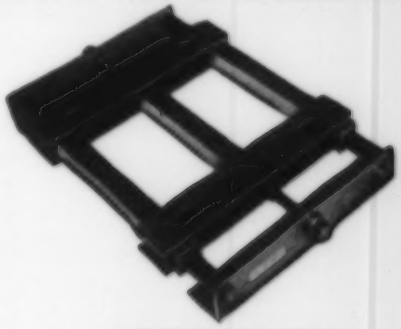


THE "SIMFLEX"

Provides Functional Utility at a Low Price. Made in two fractional sizes and for Old NEMA frames sizes 203 through 326.
Not recommended for use with motors having New NEMA frames.

THE "SR" TYPE ST

A refined product made to close tolerances. The spring and working portion of the adjusting screw are enclosed and sealed in a grease-packed tube. The smooth walls of the motor carriage cooperate with close fitting square steel rails. Made in two fractional sizes, and for both Old and New NEMA frame sizes 182 through 326-U.



THE FLEXIBLE "BB"

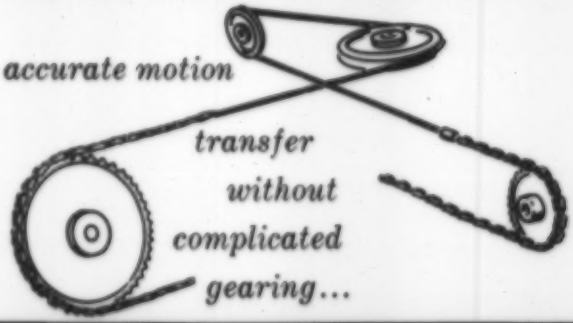
The motor carriage rolls on linear ball bearings. All working parts are grease-packed and sealed. Stocked in four sizes for NEMA frames 364 through 505. Bases for larger motors, size unlimited, built to order.

THE "SR" TYPE SQ

For motors equipped with Variable-Pitch pulleys. The BASE with 'finger-tip' control at the crank handle.
Made in two fractional sizes, and for both Old and New NEMA frame sizes 182 through 326-U.

AUTOMATIC MOTOR BASE CO.
WINDSOR, N. J.

MORE DESIGN FREEDOM



SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance —wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

NEW CATALOG

Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

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Quality
Performance
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WIRE FORMS
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You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most *trying* conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce design that meet your *exact* needs—and save you MONEY!
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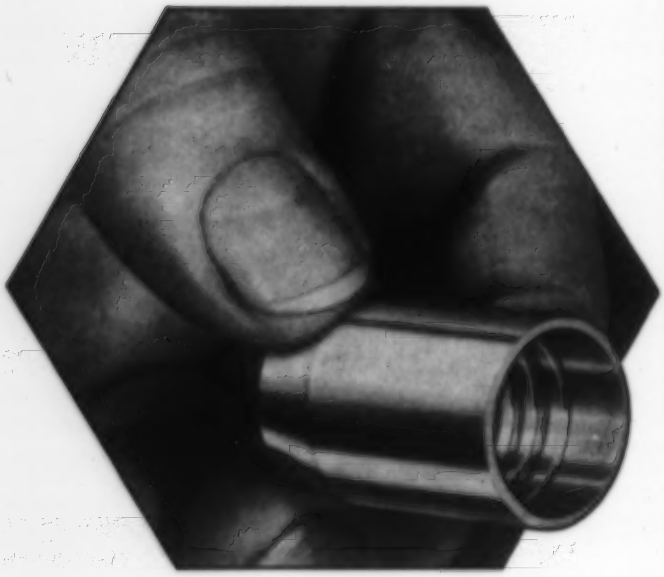
There are right feeds and speeds for this aluminum part



Alcoa offers the answers here...

On many screw machine jobs there are operations which can be done in different ways, but, there is usually just one "best" way. To supplement your own experience, Alcoa offers users of Alcoa® Aluminum Screw Machine Stock a complete technical packet containing: calculators for feeds, speeds and properties; an engineering handbook on machining aluminum; a booklet of corrected tool diameter tables; case histories of savings; a conversion chart for alloy designations. The complete packet is free for the asking. Just fill out and mail coupon today.

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873-M Alcoa Bldg., Mellon Square, Pittsburgh 19, Pa.
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Please send your technical packet on Aluminum Screw Machine Stock to:

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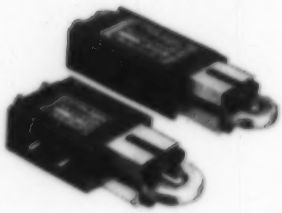
CRV SERIES ROLLER CAM VALVES



NEW Compact, Easy-Mounting Design!

FLAT SURFACES ALL AROUND, with convenient access to ports (all ⅛-27 NPT) make new CRV series valves easiest to "design into" your application. Ultra-compact—4-way is only 3/4" x 1-1/2" x 4-3/16" overall (roller cam extended).

STANDARD "O" RING SEALS throughout assure long, reliable service, are easily replaced when necessary.

CRV SERIES VALVES now available in 3 or 4-way hand lever, palm button, foot control, cam, roller or pilot-operated types. Prices range from $11.30 to $15.95, f.o.b. factory.

NO OTHER VALVE offers all these important features —why settle for less? Call your MODERNAIR dealer or write today for complete data.

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SUB-MINIATURE UNIMAX® SWITCH

Type U S M

ACTUAL SIZE

for easy wiring in miniaturized apparatus.

- Sturdy, standard flat terminals are widely spaced for rapid wiring and easy soldering.
- Case size 25/32" x 23/64" x ¼".
- Long life.
- Available in plain or leaf-actuator style.
- Rated 5 amperes at 125/250 volts, a-c. or 2 amperes at 30 volts d-c.; SPDT.

Write for data sheet.

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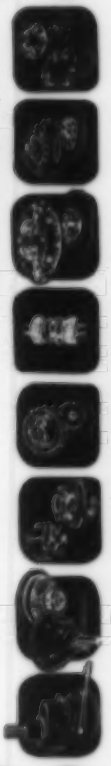
Division of The W. L. Maxson Corporation
460 WEST 34th ST. NEW YORK 1, N. Y.

ROCKFORD



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EASY OPERATION
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LARGE DRIVING AREA
SMOOTH RUNNING
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MINIMUM INERTIA

• ROCKFORD Over-Center CLUTCHES remain in or out of engagement until changed by the operator. The smooth, easy, anti-friction engagement—obtained by roller cams pressing against the pressure plate face—progresses from "release" to "on center" to slightly "over center" where the clutch locks in engaged or running position.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION
▲ 311 Catherine Street, Rockford, Illinois, U.S.A. ▲

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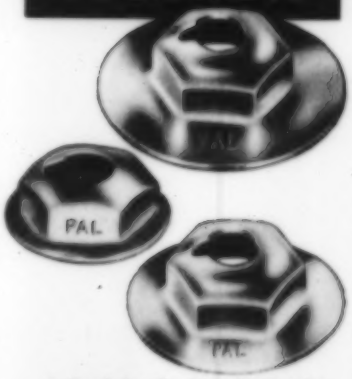
Why assemble 3 parts?

..when 1 part does the job at lower cost!

- One-piece lock nut and flat washer costs much less than ordinary nut, lock-washer and flat washer—frequently no more than an ordinary nut alone
- Vibration-proof fastening for sheet metal assemblies, components, parts and other light types of assemblies
- Saves parts and handling
- Speedy assembly with hand or power drivers
- Built-in washer spans holes and slots
- Resilient spring action provides safe, secure fastening when used on fragile parts
- Wide range of standard sizes

WASHER TYPE
PALNUT
TRADE MARK
LOCK NUTS



The PALNUT Co.
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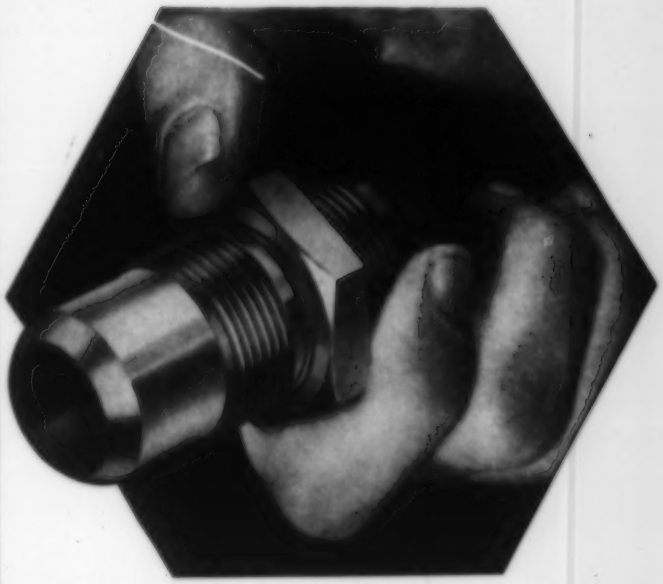
In Canada
P. L. Robertson Mfg. Co., Ltd.
Milton, Ontario

• Send details of application for free samples and literature.

There is a right way to grind tools for this aluminum part



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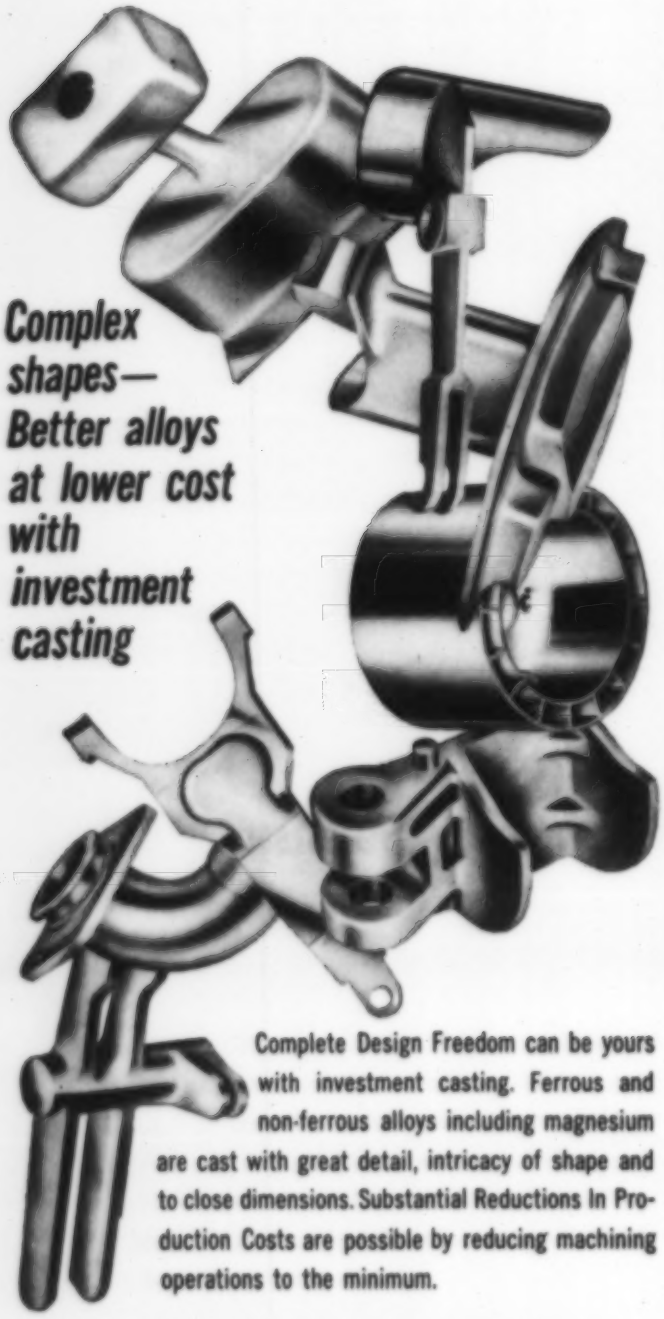

Complex shapes— Better alloys at lower cost with investment casting

Complete Design Freedom can be yours with investment casting. Ferrous and non-ferrous alloys including magnesium are cast with great detail, intricacy of shape and to close dimensions. Substantial Reductions In Production Costs are possible by reducing machining operations to the minimum.

- Assembly costs are cut by combining two or more components into an integral casting
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Arwood's four plants have complete tooling facilities and government approved inspection equipment.

If you use metal in your business investigate the possibilities of investment casting . . . send for literature or call for consultation. We welcome parts or prints.

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Bearing Material:

Attributes: More than 14 unusual characteristics.

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Data: 20 Data Sheets with full information, case histories.

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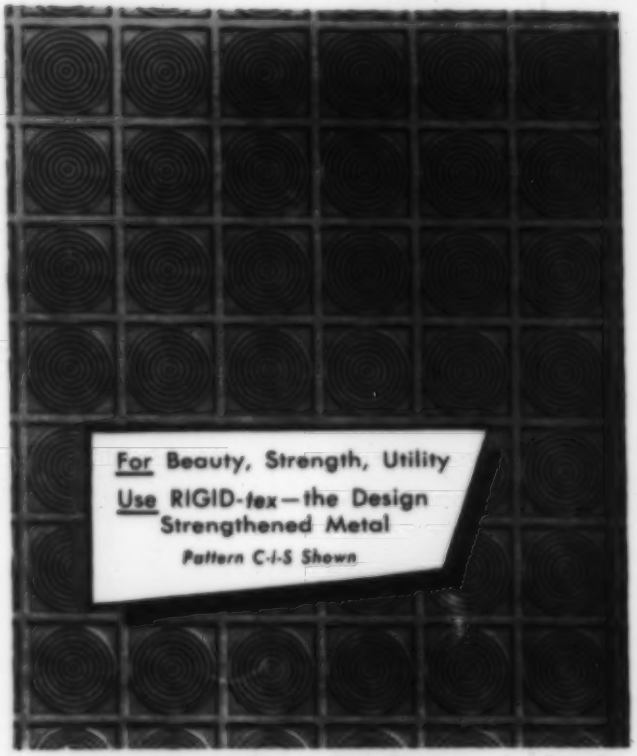

See SWEETS Design File 1a/Ri or write us for information

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Low in price, easy to install, there are seven standard Arens designs to meet light, medium and heavy load requirements. They are available with a variety of control heads, casings, and end fittings. Special controls can also be designed to meet specific requirements. Design with Arens Controls in mind . . . and save.

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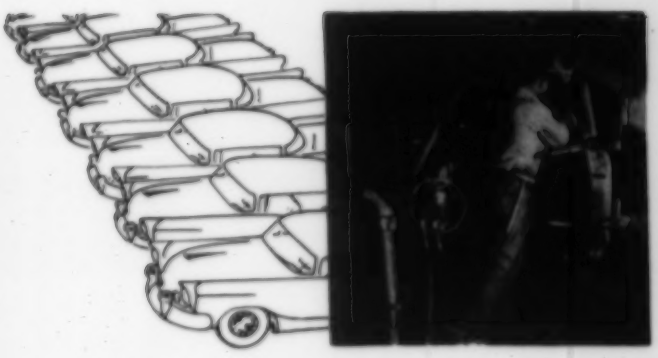
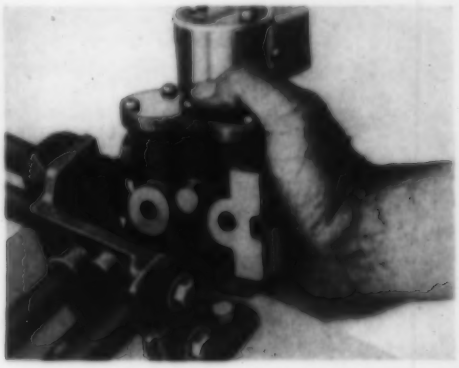
2009 Greenleaf Street, Evanston, Illinois



THEY BUILD ANOTHER CAR IN THE TIME SAVED...



How much production do *you* lose when a valve breaks down? In less than a minute you can take a Crescent® sub-base mounted four-way air valve from the line and be back in service with a new one.

But that is not the whole story. Crescent® valves are accepted on production line equipment in major automotive plants, that means they have to perform a minimum of 10 million cycles without service or breakdown.

If you are using air valves in your plant and they are not Crescent® valves, you are paying too much for them—in lost production.

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molded BRUSH CAPS

many types and sizes

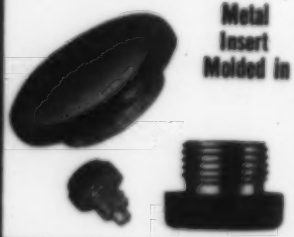
supplied from stock

to help motor makers

build better motors

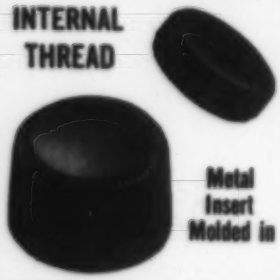
EXTERNAL THREAD?

Metal Insert Molded in



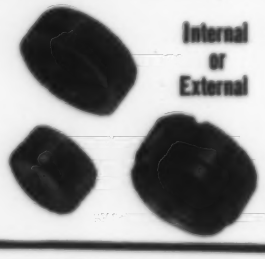
INTERNAL THREAD

Metal Insert Molded in



MOLDED THREADS?

Internal or External



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External or Internal Threads

MOLDED COMMUTATORS?

with or without prongs

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Self-adjusting DC motor speeds from AC lines!

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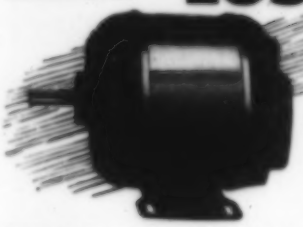
MATCHED COMBINATIONS

C-25 ELECTRONIC TUBE OPERATED CONTROLLER

with matching

¼ H.P. DC MOTOR

Complete, F.O.B. Baltimore, Md. $183



Other plain and gear motors available

SPECIFICATIONS

- Input: 110-120 V., 60 cy. single phase
- Output: 0-120 V., 2.5 amps DC to armature
- Field constant voltage 110 V. DC
- Full ¼ h.p., ball bearing, Master shunt wound DC motor. 200-2000 R.P.M.
- Dynamic Brake ● Reversible ● Full torque

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Need no insulation . . .
Can't rust . . .
Can't corrode . . .

● CUT ASSEMBLY TIME

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FOR WATER: Single Heat, 500 to 3000 watts. Three Heat, 500 to 10,000 watts.

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Larger and smaller sizes made to order, as well as units to suit special applications.

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Heating Units for any device that uses electric heat. Electric Soldering Tools, Electric Glue Pots, Solder Pots and Melting Pots. Electric Branding Irons.

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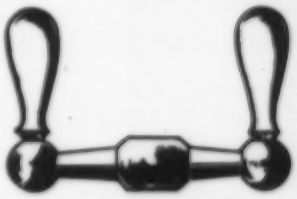
HIGH QUALITY AT MODERATE PRICES!

Balanced Cranks, Compound Rests and Clamping Levers



COMPOUND RESTS WITH TWO HANDLES

CLAMPING LEVERS

Machined from solid bar steel and polished to smooth high lustre.

Cast Iron Hand Wheels

DISHED

COUNTER BALANCED

Also solid web. Fine grain cast iron. Rims and handles polished to high lustre. Many sizes.

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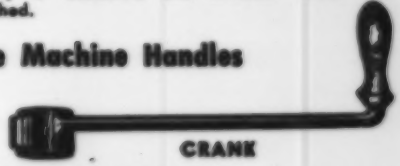
Round Plastic | Oval Plastic | Round Steel

Made in a wide variety of diameters and threads. Steel ball handles are highly polished.

Malleable Machine Handles



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Please send me FREE 60 page catalog, illustrating and describing the REID line of necessary and hard-to-get components and accessories.
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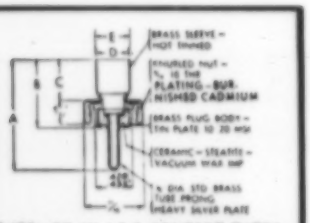
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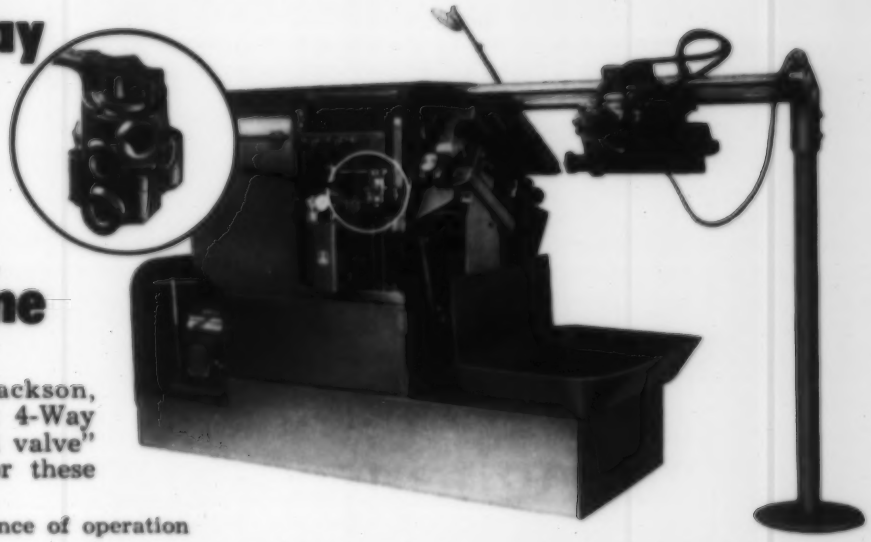

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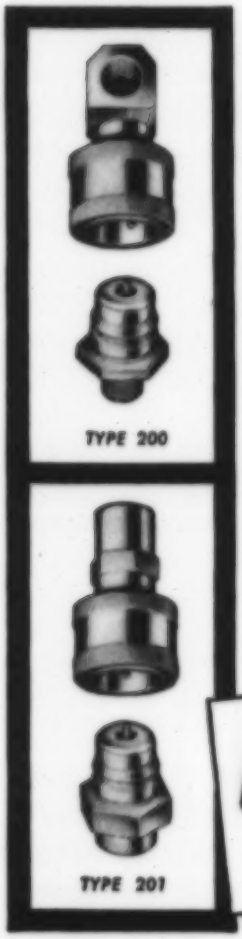

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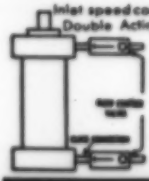

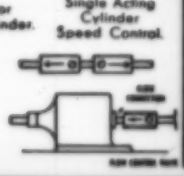

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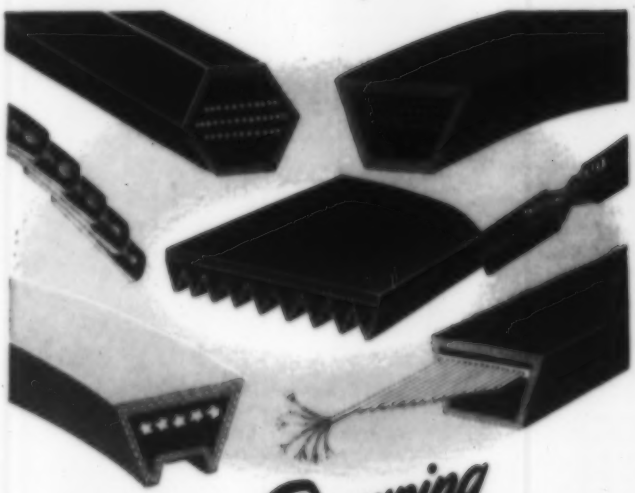

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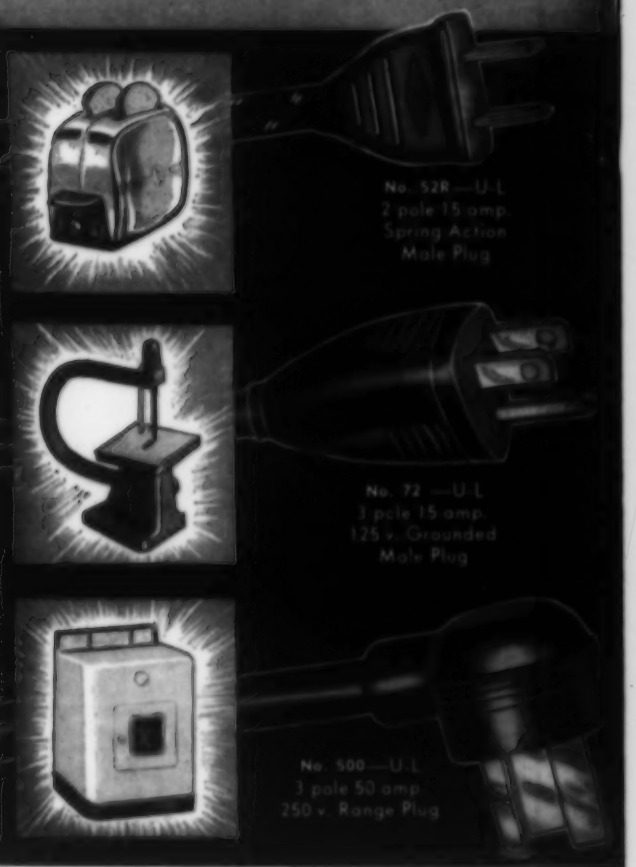

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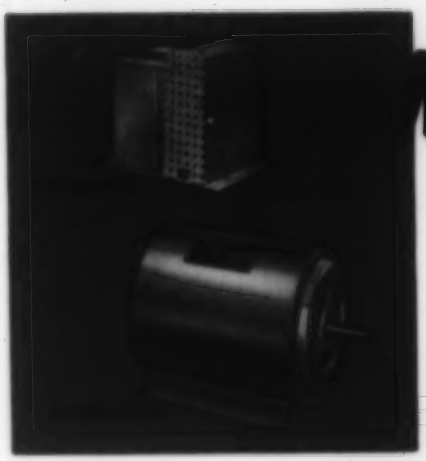

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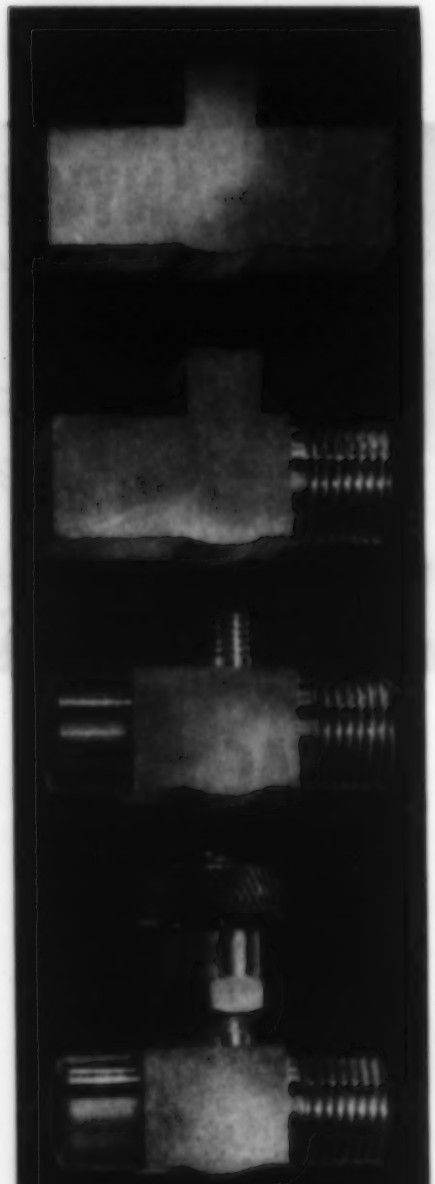

Progressive steps in producing valve, beginning with the shape as supplied, cut to length.

Huber Type 100, Model A Brazing Torch.

This is the story of a Brazing Torch valve body, made by Huber Industries, Cincinnati 38, Ohio, chiefly out of a brass extruded shape furnished by Revere. As a result of experience Huber has become an outspoken advocate of shapes. Here are the five advantages Huber has found:

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The only part of this valve not of brass is the stainless steel conical valve stem.

An extruded shape costs more per pound than standard rod or bar, but the reductions in machining, finishing and other costs much more than make up the difference, and you save money. If you are machining copper and copper-base alloys, or aluminum alloys, get in touch with Revere and learn the advantages of extruded shapes.

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THE MASTER ELECTRIC COMPANY
Dayton 1, Ohio

MASTER ELECTRIC MOTORS

New heavy-duty precision lathe mounts spindle on TIMKEN® bearings for maximum rigidity thru 12-speed range

THE new Atlas-Clausing 5300 has new massive headstock and tailstock, heavy-duty bed and carriage for rigidity and stamina. The spindle bearings must have high precision, must maintain that precision at all speeds, under heavy loads. That's why Atlas-Clausing chooses Timken® precision bearings.

Timken bearings, because of their tapered design, take radial and thrust loads in any combination, hold spindle in rigid alignment. There is no end play. Timken bearings assure precision at all times.

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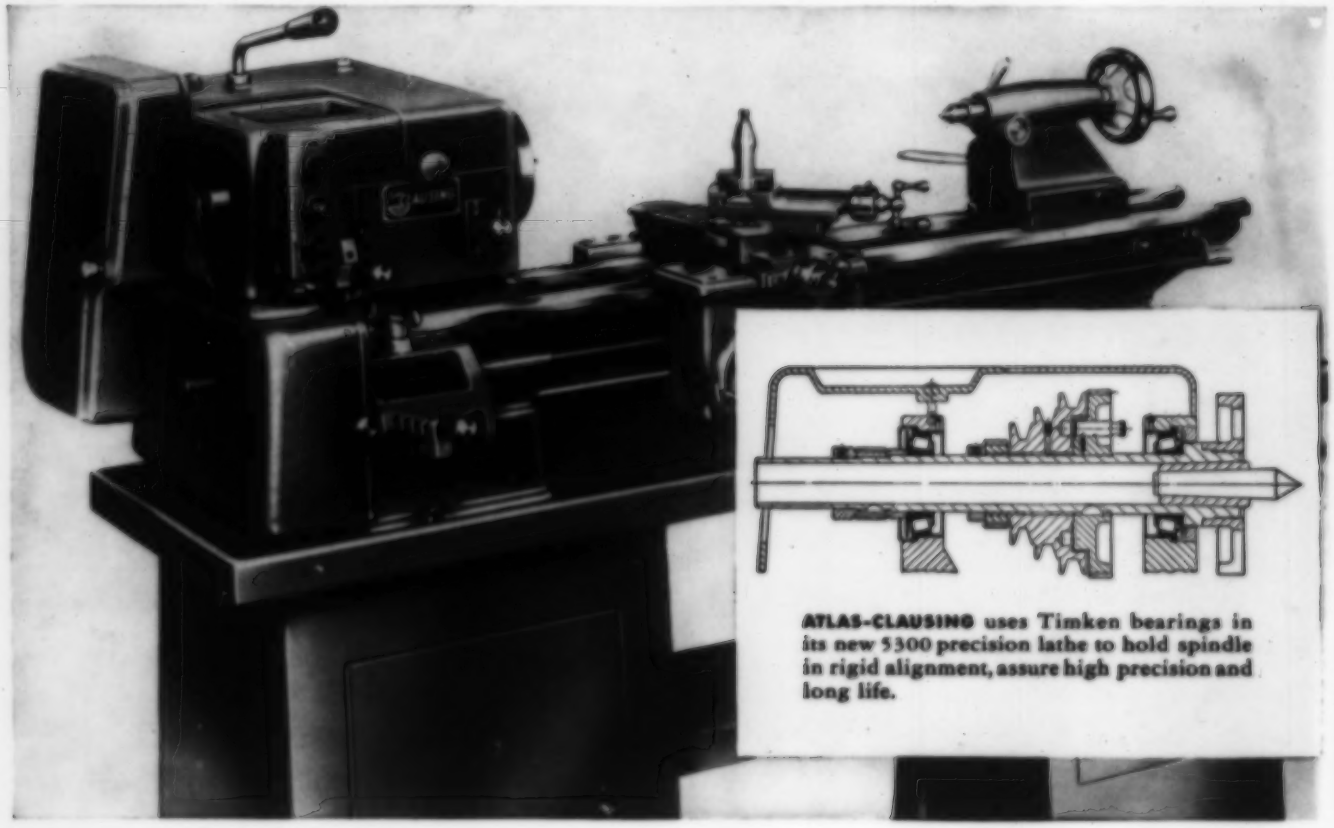
Timken bearings save power because they practically eliminate friction. They are geometrically designed to give true rolling motion, precision manufactured to live up to their design. And to make sure we get steel good enough for Timken bearings, we make it ourselves. No other U. S. bearing maker takes this extra step to insure quality in every bearing.

You can get all the advantages of Timken bearings only by specifying Timken bearings in all the equipment you build or buy. Look for the "TIMKEN" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



ATLAS-CLAUSING uses Timken bearings in its new 5300 precision lathe to hold spindle in rigid alignment, assure high precision and long life.

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

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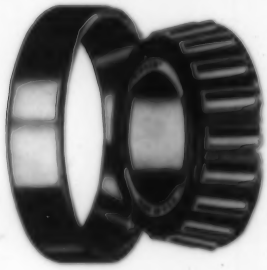

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